SCIENTIFIC AMERICAN SUPPLEMENT, No. 945

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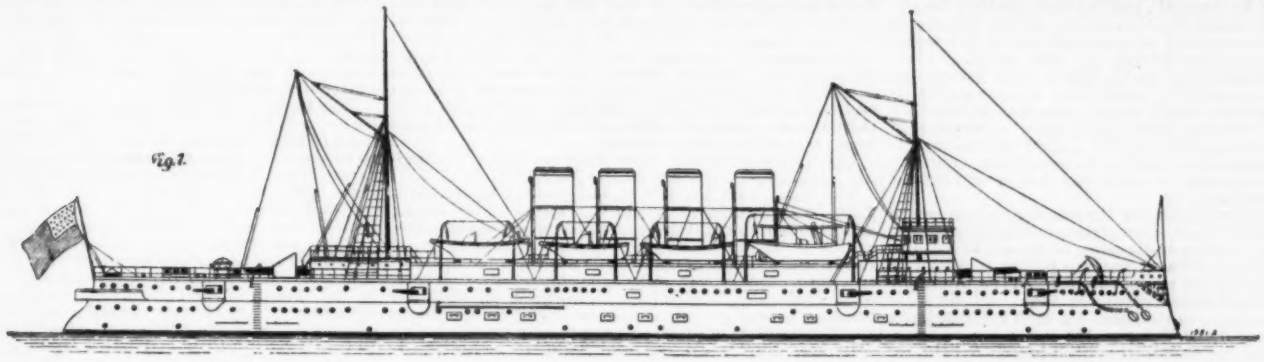
Scientific American Supplement, Vol. XXXVII. No. 945
Scientific American, established 1845. NEW YORK, FEBRUARY 10, 1894. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE UNITED STATES WAR SHIP COLUMBIA.

IN our SUPPLEMENT 935 we gave a view of this great ship, and we now present another illustration, showing the vessel as photographed when running at high



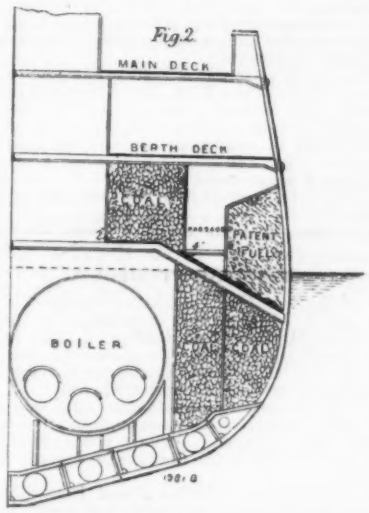
speed on her trial trip. On this occasion, December, 1893, her mean speed was 22·81 knots per hour, thus showing her to be one of the fastest vessels afloat. Our present object is to let our readers know how she appears to the eyes of others, and this is what is said of her by *Engineering*, London. It is from the pen of Mr. William Fairburn. In the Columbia the United States has sought to produce a vessel absolutely without parallel as a commerce destroyer among the war ships of the world. The combination here made unites a sufficient armament with complete protection against light guns, while at the same time the vessel has a sea speed of close on 23 knots, and a coal endurance hitherto unknown in ships of war. She is a match for the swiftest transatlantic liner afloat to-day carrying an armament of which such a vessel is capable, and no merchant vessel that she meets, armed or unarmed, can escape her.

The Columbia was lately built at the yard of Messrs. Wm. Cramp & Sons, of Philadelphia, the contract price for hull and machinery being $2,725,000, though the complete cost, including armament and speed premiums, is estimated at $3,600,000, or about £750,000.

The following are her principal dimensions :

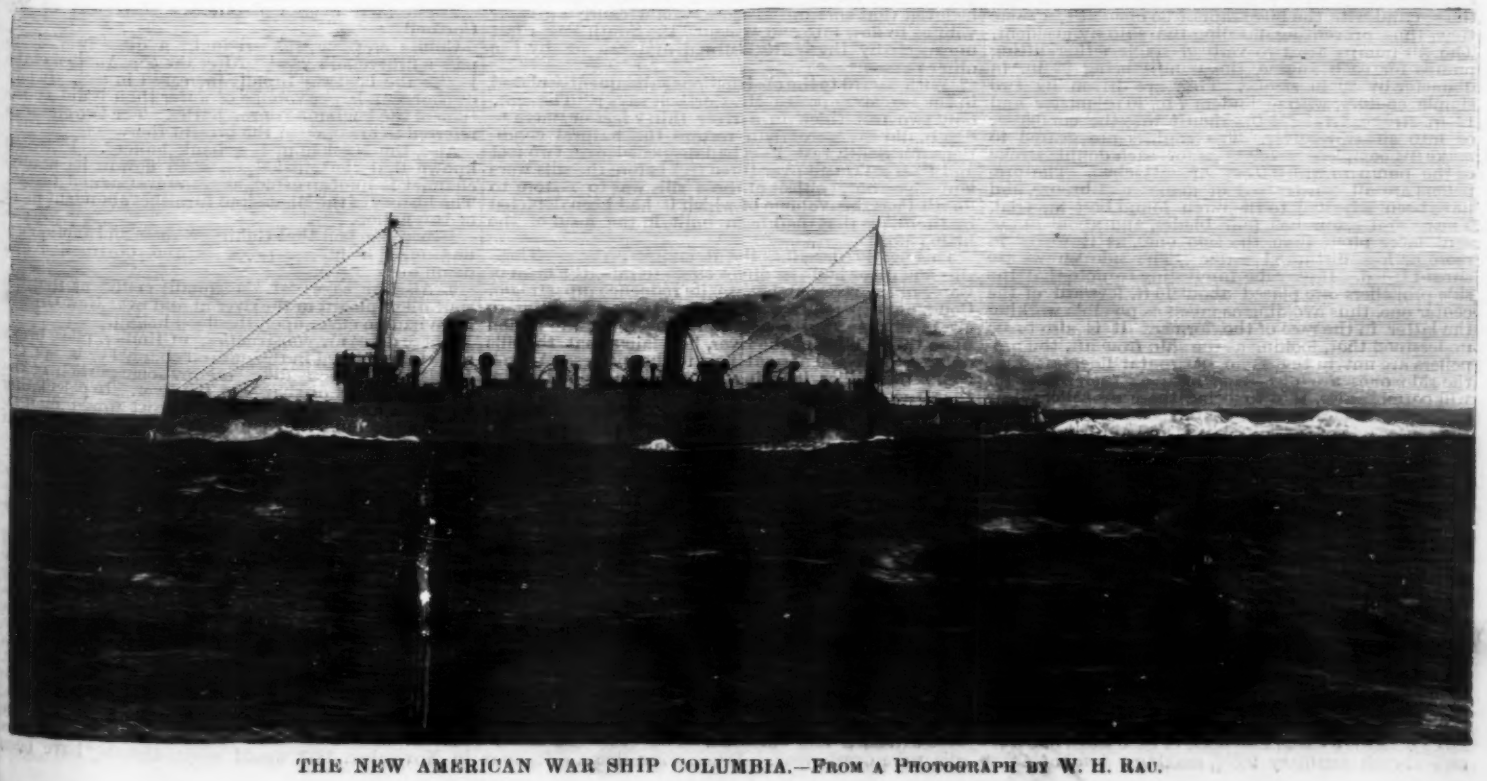
Length on load line.....	412 ft.
Beam moulded.....	58 ft.
Draught, mean normal...	22 ft. 6½ in.
" " load....	25 ft. 5¼ in.
Normal displacement	7,356 tons.

She is constructed throughout of steel, a double bottom being worked the length of the machinery and boiler spaces, while forward and aft of this the frames consist of continuous Z-bars, spaced 42 in. apart, the transverse frames in the machinery spaces being 48 in. apart. The vessel has three complete decks, including the armored deck, also a large superstructure or bridge deck amidships, on which are carried the boats, etc. A rounded steel protective deck runs the full length of



the vessel. This deck is 4 in. thick on the slopes, and 2½ in. elsewhere ; the top of the deck beams at sides being 4 ft. 6 in. below the load line, and the beams at center generally 1 ft. above, except at the ends, where the deck tapers down to the side line of the beams. The flat or crown of the deck is worked in two thicknesses of 1¼ inch steel plates ; on the slopes over the machinery and boiler spaces an additional thickness of 1½ in. is worked on top of the 1¼ in plates, making the total thickness on slopes 4 in. A cofferdam 60 in. in width is worked between the protective and berth decks at the water line region, and extends completely around the ship, the space in the central portion being filled with patent fuel, capable of use in an emergency, and forward and abaft with water-excluding substance, such as cellulose. An additional safeguard against the effects of damage near the water line is formed by the storage of coal on the armored deck.

The main battery of the Columbia consists of one 8 in. and two 6 in. breechloading rifles, and eight 4 in. rapid firing guns, while the secondary battery is made up of twelve 6-pounder and four 1-pounder rapid firing Hotchkiss rifles, four Gatling guns, and six 15 in. torpedo discharge tubes, two of which are submerged. The total weight of the vessel's all-round fire is 790 lb., of which 402 lb. can be fired directly ahead, 356 lb. astern, and 520 lb. on either beam. In wake of the 4 in and machine guns, the ship's sides are protected with 4 in. and 2 in. steel plates. The two 6 in. guns are mounted on the main deck aft, and the 8 in. gun forward in the open, and all three are well protected by heavy steel shields attached to the gun carriages. The vessel's freeboard to the main deck is 20 ft., and this, together with her great length, will enable her to fight her guns and maintain her speed in a sea that would render smaller ships practically useless. The full complement of the Columbia consists of about 500 men, and both the officers and crew are accommodated on the upper and lower berth decks, the former being generally called the gun deck. The officers' accommodation consists of handsomely fitted cabins situated aft, the superiors being located on the upper deck. The vessel is fitted as a flagship, the admiral's quarters being at the extreme aft end of the upper berth or gun deck, and in



THE NEW AMERICAN WAR SHIP COLUMBIA.—FROM A PHOTOGRAPH BY W. H. RAU.

direct communication with a handsome stern walk. The crew's accommodation forward is much superior to that ordinarily found on modern high speed war ships, and their quarters are spacious, comfortable, well lighted and ventilated.

The arrangement of the Columbia's motive power is somewhat novel, as the force is transmitted through three screws, one placed amidships as in ordinary single-screw vessels, and two others placed farther forward, one on each side, as is usual in twin-screw vessels. This arrangement in war vessels is not entirely new, having been adopted by the French in some of their high speed modern ships, and more recently by the Germans in their Kaiserin Augusta, but it represents the latest advance in the steam engineering line where such great power is to be transmitted. If twin screws were used, 11,000 indicated horse power would pass through one shaft; now each shaft transmits only 7,300 indicated horse power, and the vessel has one more chance in case of breakdown. Referring to the triple screws fitted on the Columbia, Mr. George W. Melville, the Chief of the United States Bureau of Steam Engineering, of the Navy Department, says:

"Knowing that it was extremely improbable that shafts of the great size necessary to transmit this enormous power to twin screws could be obtained in this country, either in reasonable time or with any guarantee as to strength, the bureau decided to depart from the usual practice, and to divide the power into three parts instead of two, each being developed by a separate engine driving its own screw. It was still further influenced to do this by the knowledge that even in case of the recurrence of so remarkable an accident as that which lately happened to the City of Paris, this cruiser would still have a reserve of power sufficient to drive her at a good rate of speed. Indeed, it is almost impossible to conceive a combination of circumstances or accidents that would render her entirely helpless."

The machinery consists of three independent sets of vertical inverted direct-acting triple-expansion engines, the cylinders having a diameter of 42 in., 59 in., and 92 in. respectively, with a common piston stroke of 42 in. The main valves are of the piston type, there being one double-ported valve for each high-pressure cylinder, two single-ported ones for each intermediate, and four single-ported ones for each low-pressure cylinder. The valves for the high-pressure cylinder are not packed, while those for the intermediate and low-pressure cylinders are packed in the usual manner with rings. The diameters of the valves are—high pressure, 18 in.; low pressure, 21 in.; intermediate pressure, 23 in. They are driven by Stephenson double bar links fitted with steam reversing gear and hydraulic controlling cylinders. The intermediate and low-pressure cylinders are steam-jacketed, and the high-pressure cylinders provided with a lining, all the liners being made of cast iron as hard as tools can work it.

The cylinders are supported at the back by inverted Y frames, to which the slides are attached; they are supported on the front by cast steel cylindrical columns. The bedplates are of cast steel of I-section, well ribbed. The piston, connecting, and all working rods are of forged steel. The condenser shells are rolled brass ¼ in. in thickness, with cast brass heads containing the various nozzles and openings. The sheets are riveted together and to the heads, and the joints then soldered. They are also fitted with man holes and plates, and facilities for boiling out and cleaning. Each condenser contains 4,904 seamless drawn brass tubes, tinned on both sides, 11 ft. 10 in. long, No. 20 B.W.G. thick, ⅝ in. outside diameter. The tubes are so packed that each may expand freely, but are prevented from crawling. Each condenser has 9,496 square feet of cooling surface, and the interior is so divided by diaphragm plates that the steam is brought into contact with all the parts of it, thus rendering the whole of it efficient.

Condensing water is supplied to each condenser by two circulating pumps, each capable of discharging 6,750 gallons per minute. These pumps are made of composition, with phosphor bronze runner shafts running on lignum-vitæ bearings in the water space. They can also be used as bilge pumps in case of a leak, and are so fitted with valves that communication with the sea and with the bilge cannot be open at the same time, thus preventing flooding the ship by accident. The air pumps are two vertical single-acting lifting pumps for each engine, the pumps being 22 in. in diameter by 20 in. stroke. They are driven by two simple engines, with cylinders 7 in. in diameter and 12 in. stroke, arranged to exhaust into the condenser or into either receiver. The engines are geared to make 2⅛ complete revolutions for each double stroke of the pump to which they are attached. The propellers are all constructed of manganese bronze, and have been adjusted to the pitch found best on trial. The central screw has four blades, and about 10 per cent. more pitch than the side ones, as it works in more or less disturbed water. The side screws are three-bladed. It may be interesting to note that the side propellers are placed about 15 ft. forward of the center one, thus avoiding as much as possible working the latter in the race of the former. It is also to be understood that, looking at the ship from aft, the propellers are not in the same horizontal line, but that the side ones are placed as high as their diameter will permit; also, that to bring these propellers clear of the ship's sides the side shafts incline outward from the center line of the ship 4 deg., and also slightly upward. The shaft of the center propeller is in the central longitudinal plane of the ship and inclined slightly downward, making the center of this screw 52 in. below that of the side screws.

Steam is supplied by eight main and two auxiliary boilers, all built of mild steel. Six of the main boilers are 15 ft. 6 in. in diameter outside and 21 ft. 3 in. long, and two are 11 ft. 8 in. in diameter and 18 ft. 8 in. long. The shells of the large boilers are 1⅛ in. thick, those of the smaller ones 1 1/16 in. The two auxiliary boilers are 10 ft. in diameter and 8 ft. 6 in. long, and all are constructed for a working pressure of 160 lb. to the square inch. The main boilers are of the Scotch type, double ended, and with 2¼ in. steel tubes. Each large boiler has eight corrugated steel furnaces of 39 in. internal diameter, and each small one four, with an inside diameter of 42 in. The heating surface of each large boiler is 5,932 square feet, of each small one 2,870 and of each auxiliary 968⅛, making a total of 43,360 square feet. The total grate surface is 1,285 square feet, each large boiler having 175·5 square feet, each small one 84 square feet, and each auxiliary 32 square feet. The auxiliary boilers are placed above the protective deck, while the main boilers are arranged in groups of two in four separate watertight compartments, with five athwartship firerooms and four large smoke pipes.

The forced draught is on the closed fireroom system, each fireroom being fitted with two large Sturtevant centrifugal fan blowers. Feed water is supplied by a main and auxiliary feed pump in each working fireroom, and an auxiliary feed pump in each engine room.

There are evaporators, distillers, reversing and turning engines, fire and bilge pumps, ice machines, steam ash hoists, steam windlass, capstans and steering gear, and all the other auxiliaries now fitted to modern war vessels.

A feature of the motive power design that carries a strong argument in its favor is that by means of clutch couplings either propeller can be disconnected from its engine and left free to revolve, thus retarding the way of the ship but very slightly when she is being propelled by one or two engines. A still further advantage is that in moderate cruising, say with one-third power, a few boilers can be used with the high steam pressure for which they are intended, and one engine driven at the full power for which it is designed. By this means the power will be obtained economically instead of wastefully, as is the case when a large engine is run at a low power. It has been estimated that with one-third power and one screw the ship can be driven about 15 knots; with two screws and two-thirds power, from 18 to 19 knots, the screws not in use being allowed to revolve freely.

The weight of all the propelling machinery, including auxiliaries, water spaces, etc., is 1,953 tons.

The total coal bunker capacity of the Columbia is 2,080 tons, which, at a cruising speed of 10 knots, will give her an endurance of 105 days and an effective radius of action of about 25,600 knots, therefore she needs neither colliers nor coaling stations, for she carries both between her decks. In other words, this ship, so powerful in offensive force as to equal all ordinary cruisers, so well protected as to be hardly vulnerable to the lighter class of guns, so abundantly supplied with separate engines as to be incapable of being wholly disabled, can steam completely round the world without touching at any point for coal, and without receiving fresh supplies from colliers, and yet when the occasion arises she can overtake with ease the fleetest of the ocean greyhounds.

Speaking of the Columbia's great cruising qualities, Secretary Tracy, of the U. S. Navy Department, says: "A dozen such vessels would, in my opinion, exterminate the commerce of any country under the present conditions of commerce protection, and would thus, under these conditions, absolutely preclude an attack from a commercial state, however threatening in its demands, powerful in its armored fleets, or aggressive in its foreign policy."

THE JETTIES AT THE MOUTH OF THE MISSISSIPPI RIVER.

Editor of the Scientific American Supplement:

Your issue of December 9 contains a letter by E. L. Corthell, President Southwest Pass Improvement Company, replying to "one or two statements" in my article on the Mississippi River published in the SUPPLEMENT of November 11, 1893.

Mr. Corthell tacitly admits the anomalous high water condition at New Orleans as stated in my article, but omits to indicate or explain the cause. Also, a feature of his letter is the absence of facts to support its assertions.

1. Mr. Corthell says: "The almost immediate effect of placing obstructions in the head of South Pass was the deepening of the two large passes on each side, which carry to the sea ninety per cent. of the volume of the main river" by "turning the volume of South Pass."

Which, in fact, proves the initial work to have been a dam. Here the blunder began. It was intended and believed that this initial work would cause a greater volume to flow into and "scour" the South Pass; but unexpectedly the water turned and ran off by the other passes.

2. With regard to the obstructions subsequently placed in the two large passes Mr. Corthell says: "The sills, only two feet thick in a river thirty feet or more in depth, did no more than restore the natural conditions, for Southwest Pass had deepened over two feet and Pass a l'Outre over three feet before the sills were laid. The only object of these sills was to restore to South Pass the volume of which it had been depleted by the dikes that had been built in the head of the little pass."

This neatly describes the damming process. These sills and dikes had the direct effect to raise the head of water in the river and cause its refluence up stream. Common experience will confirm this effect. But to evade this natural conclusion concerning the action upon the volume of the river, he claims that the sills only restored the normal flow to the passes. As well could the miller, ignoring his dam and pond, claim that the normal volume of the stream ran over his weir. The writer of the letter should logically demonstrate how it were possible for "obstructions" in the South Pass which turned the flow of the Mississippi, followed by other "obstructions" in the two large passes causing refluence of the volume, could act otherwise than back up the water in the river. Even the small boy practically understands damming by "sill" when he places a stick upon the bed of a meadow brook to make a pool above in which to catch minnows.

With regard to the height and character of these sills, I prefer Captain Eads' testimony that in places the "sills were raised five feet;" of others "which brought it above the water;" and that, "where these dams were built in water 18 feet deep, after one season of flood we found it difficult in getting a yawl boat near to them."

It became absolutely necessary to impose upon South Pass a greatly increased volume. The works were extended and enlarged. The "two feet thick" sills were overtopped. Dikes, wing dams, sills, spur dikes, piers and other devices were employed. The works proved so effective that the two large passes, which before had carried all the commerce, shoaled and were lost to navigation. In consequence these main channels, which before had discharged ninety per cent. of the volume of the Mississippi River, were dammed.

These facts concisely represent the actual situation at the mouths of the Mississippi.

3. Mr. Corthell says: "I can assert that no results whatever in raising the river one inch at New Orleans have ever proceeded from any of the works at any time placed in the passes of the Mississippi River."

Considered in relation to the unquestioned data in my article, showing the conduct of the river at New Orleans in the rise of 1892 and 1893, this assertion will collapse.

President Dreyfous, in his recent annual message to the New Orleans levee board, states: "It is noteworthy that the stage of water has grown higher yearly since 1890."

It is known that no great rise from the Ohio River occurred in these years: that Red River, by means of government works, discharged its flood volume down the Atchafalaya: that no natural condition obtained to cause this higher yearly stage; also, it is known that artificial works have been constructed which reduce the effective area of discharge and consequently raise the flood surface; therefore the conclusion is reasonable and must stand until overset by superior proof—that this condition of higher yearly stage at New Orleans is caused by the jetty system, of which the works in the mouths of the Mississippi are most pronounced and obstructive in their effect.

This higher stage last year at New Orleans exceeded by one and nine-tenths feet the high water of the great flood of 1884. An inch of water at New Orleans is held to be most significant by river men and scientists. The action of the Mississippi is testimony of the highest character and is to be preferred to the assertion of an interested person. This higher yearly stage concerns New Orleans and the Mississippi Valley.

There is a diurnal tide in the Gulf of Mexico at the mouths of the passes having a mean rise of one and one-half feet. It is known that a maximum or spring tide at the mouth of Southwest Pass previous to the construction of the jetties caused a rise of three-tenths or four inches at New Orleans during high flood period in the Mississippi. The tide is only temporary, occurring once in twenty-four hours. It is practically a water bar of brief duration.

When, therefore, a transient water bar having a height of one and seven-tenths feet at the mouth of Southwest Pass shall cause a rise at New Orleans, still more shall permanent dams in the mouths of the Mississippi of greater height and obstructive character cause a much higher stage of water at New Orleans. The obstruction being permanent, it is obvious that the highest stage will also be continuous, until the Mississippi finds an unobstructed channel to the gulf.

4. Again, Mr. Corthell says: "If the dams had raised the water to any appreciable extent and prevented its free flow to the sea by the three passes, it would have at once sought relief through these crevasses (Cubits and another) and kept them open to their full size, which it did not, or made others immediately, for the bed and banks of the river here are composed of material moved with the greatest ease by any acceleration of the current."

This statement is misleading and erroneous. The Mississippi has made repeated attempts year after year to open a new channel and escape from the obstructions. The resources of the jetty company have been taxed to close these breaks. Witness one instance. An upper dam, 1,675 feet in length, near Pass a l'Outre, constructed in 1879, was attacked three years ago by the river. The government officer reported that 1,163 feet of this dam had been washed away, that "the channel is still increasing, the dam is being rapidly undermined and carried away, and in turn the rapid current encroaches upon the land formation below and it is wearing away rapidly. Another attempt will be made to close Pass a l'Outre crevasse during next low water season, though, in the meantime, if the remaining 512 feet of the upper dam should be carried away, the effect upon South Pass may be serious."

These facts overset the above statement of Mr. Corthell.

Cubits crevasse was originally a dugway made to pass a fisherman's yawl. After the construction of the jetties the boatway rapidly increased in size. It now discharges a larger volume of water than it did at the time of the beginning of the jetties. The two crevasses referred to are open at the present time.

Also, the Mississippi is a bank builder. It is well known that the Mississippi, when flow in its natural channel is unobstructed, closes crevasses and breaks. The history of the Mississippi furnishes abundant proof of this action.

Hence, the fact that Cubits crevasse and another are now open is precise proof of the obstruction and damming.

5. Also, he says: "I am equally confident that the spur dikes placed in the river at and near New Orleans have had no effect upon the flood height."

These dikes are constructions of timber, piles, brush and stones placed in the natural channel or bed of the Mississippi. These dikes occupy some portion of the effective area of discharge of the river. In calculating this area for the section, the scientist would unquestionably exclude the volume of the dike. It is well known that material of this sort upon the bed of the river obstructs the flow and raises the head of water. Hence, these spur dikes are directly implicated in the high water condition at New Orleans, the same relatively as are the sills and dikes in the passes. One illustration of their effect upon the river will be given.

In 1887 there was an extreme and long-continued drought throughout the entire Mississippi Valley. The water in the Mississippi reached a lower stage than for twenty years. At Vicksburg the mean stage for the month of November was four and two-tenths feet below the mean stage for November, 1886. At New Orleans the mean stage for November, 1887 was one-tenth of a foot higher than the mean stage for November, 1886. It is to be recalled that the flow for November in both of these years was remarkably even at both places. Had natural relativity of stage obtained, or had the Mississippi been unobstructed, the stage at New Orleans in November, 1887, would unquestionably have been

one foot to one and a half feet lower than it actually was.

The chief signal officer, after a searching investigation of this stage of water at New Orleans, of the integrity of the gauge and of related conditions, reported: "There is shown to be a relatively high stage at New Orleans. The cause of this may be due to the fact that there is a gradual obstruction to flow, owing to an accumulation of some sort in the vicinity of New Orleans."

The cause is found in the artificial works and resultant sedimentary accumulation.

No other solution is possible from the given phenomena.

6. Of the proposed improvement of Southwest Pass Mr. Corthell says: "All that the company which is organized for this purpose desires is that the natural normal volume of this pass be given it. This the pass now has. We intend only to build works in the mouth of this pass in the Gulf of Mexico, and we believe that this is all that is required to give a permanent channel of much greater dimensions in width and depth than it is possible to make in the little pass."

I maintain the Southwest Pass has not its natural normal volume. It has been deprived of its normal volume by the dams and their consequent shoaling of the pass. The well-known fact that the normal volume of South Pass has been greatly increased, is precise proof that the normal volume of the two other passes must have been decreased.

Granted the normal volume for the Southwest Pass, and that the proposed works be built in the mouth of this pass in the Gulf of Mexico, it will not be possible to obtain a permanent channel of the width and depth claimed by Mr. Corthell.

The present action of the Mississippi River is a positive demonstration that the results hoped for by Mr. Corthell will not be obtained by the present incompetent plan.

WILLIAM L. ELSEFFER, C.E.

18 Broadway, New York City, January 8, 1894.

VEGETABLE PARCHMENT: ITS PROPERTIES, USES, AND MANUFACTURE.

VEGETABLE parchment has been known as a commercial product for very many years. It was first manufactured as a substitute for animal parchment for use in certain branches of industry, as it was found to fulfill all the necessary needs which the real parchment had hitherto supplied. It is besides a much cheaper product, and for many purposes a superior one. A steady and large demand exists for it at the present day, the consumption of it in this country being very large; but, strange as it may appear, only small quantities are produced in England, the larger part of this branch of the paper manufacture being confined to Germany.

The composition of vegetable parchment has been studied by many chemists. According to Girard it is essentially a hydro-cellulose. It is perfectly odorless, and when well made is of uniform texture, resembling in appearance the skin of a bladder. It is translucent and possesses the unique properties of retaining its toughness when thoroughly wetted with water and of regaining its original strength when dried. It is practically grease proof, but although not altogether impervious to water, is known to effectually protect, in a large measure, commercial goods in the wet or dry state from the influence of moist or dry air.

Its uses are very various. As a substitute for animal parchment, with which it is closely allied in reliability and hygroscopic properties, it has been used for many years in the bookbinding trade; and, also, for documents where durability is of paramount importance. It is not attacked by insects like animal parchment, and if properly made is quite as durable. Owing to its strength, durability, and great toughness when saturated with water, it is extensively used for covering vessels containing fruit and other preserves, sirups, etc., and in the preservation of polished brass and iron goods. In the provision trade very large quantities of the thinner kinds are consumed annually for wrapping up butter and other fats.

THE RAW PAPER.

The raw paper which is to be transformed into parchment must be chemically pure, that is to say free from lime, soda, chlorine, etc., and be as spongy as blotting paper. It must be prepared without the usual sizing (resin soap) or alum. Different raw materials are used for the various strengths of parchment papers, because the method of treatment also varies. When the raw stock is intended for thick parchment, it should be soft and possess great absorbing power; while for medium and thin qualities, it should be harder and stronger, so that it can be parchmentized without fear of the web breaking or tearing.

It is advisable to use cotton rags exclusively for thick papers having a weight of 75 to 150 grammes per square meter. These rags, after bleaching, are manipulated in the same way as for blotting papers. The treatment of the raw stock in the beating engine depends upon the thickness of the desired paper, and must be conducted on well-known lines. If thick papers are being made, the pulp should be finely beaten, but for medium and thin weights the fibers must not be too short. Thick papers should also be made on the machine without the use of pressure, while thin and medium sorts should receive a little pressure, in order to enable them to withstand the parchmentizing process. A small quantity of linen rag stock can be mixed with cotton, in the preparation of the latter kinds, so as to obtain a stronger paper in endless rolls. In certain known kinds of thick parchments the addition of 30 or 50 per cent. of linen rags is necessary, viz., for osmose parchment, used extensively in the manufacture of sugar. Great strength and porosity are desired in this parchment paper, because the sugar sirup has to pass through it, and, as is well known, linen fibers are parchmentized less quickly than cotton fibers. It is, however, necessary to guard against preparing the pulp too hard, as good parchment paper must be parchmentized through and through in order to allow the osmose of the liquid to go on properly and well. When preparing parchment for this purpose it is absolutely necessary to do so from clean stock, *i. e.*, rags free from foreign substances. In no case should it be attempted to make raw paper from anything but well-sorted and clean rags, and to prepare these with water free from sedimentary matter, such as coal dust, sand, etc. The presence of alumina, chlorine, and more especially of particles of lime in such papers, is ruinous, for the obvious reason that the lime forms a compound with the sulphuric acid and produces faults in the parchment, which, although they can only be found by the experienced worker, yet render the whole sheet entirely worthless.

This is likewise the case with other impurities, such as coal dust and sand. Indeed, a high class, properly made paper is the necessary foundation of a good parchment; otherwise the labor of the parchment maker will be lost. There is much to be gained by the different degrees of speed with which the raw paper is passed through the acid bath and by other practical details in the mixing of the acids, etc., but it is difficult to counteract, at this stage of the manufacture, a wrong treatment of the pulp or correct impurities in it.

It is the opinion of many makers that the best parchment papers were made twenty-five years ago or earlier. As at that time no great stress was laid upon their color, the half stuff was allowed to thoroughly drain after bleaching before being reduced in the beater. The stock was then opened up, and made thoroughly absorptive; the raw paper made from it being of excellent quality, was easily and quickly parchmentized. The parchment paper was clear and bright, with a yellowish appearance, and as strong as leather. To-day, however, the demand is for *white* parchment, and if this is to be made, it is necessary to artificially color or highly bleach the pulp. By coloring, the fibers are simply veiled, while by bleaching them to a high degree of whiteness pulp is not only lost but it is hardened, the pores of the individual fibers being partly filled up. The acid mixture used in the manufacture has, accordingly, no such unlimited power over the fibers as was formerly the case, for they were then chemically pure, open, and loose. In order, therefore, to make good parchment paper, the raw stuff should be made so that the acid can thoroughly penetrate into the fibers and unite them together.

It is absolutely necessary to pay great attention to the purity of the acid, otherwise it will not parchmentize well. If it, or indeed any of the raw materials, contains dirt, such as sand or particles of coal dust, the final production will get damaged in the course of manufacture. Washing with pure water in the beater and elsewhere will aid the practical man a great deal in obtaining a perfect sheet of parchment. Every precaution should, therefore, be exercised in the sorting and boiling of the rags, and particularly in getting rid of any undissolved particles of lime or soda lye by subsequent washing with pure, clean water.

THE SELECTION OF THE RAW MATERIAL.

For some years cellulose has been mixed with cotton rags in considerable quantities for the manufacture of the raw paper in the preparation of the thinner kinds of parchments; for weights varying from 30 to 45 grammes per square meter. Soda and sulphite cellulose are equally applicable for this purpose, especially in the bleached state. Such materials possess the desirable property of great toughness, purity and power of absorption; and also the power of resisting the parchmentizing process without lessening the quality of the product. These thin papers are not allowed to absorb more of the acid than is absolutely necessary in preparing parchment in endless rolls, because the absorption increases the porosity in every case. This can be detected by holding a piece of the product toward the light, when it will be noticed that it is covered with numerous small holes. These render it practically useless for wrapping up butter and other fatty products and for preserving commercial goods against water and moisture.

Wood pulp, *i. e.*, ground wood, on the other hand, is quite unsuitable for making vegetable parchment. The sap and resinous bodies which it contains not only spoil the acid mixture, but produce yellowish specks on the surface of the parchment. These specks consist of a combination of the acid and the resin, etc., and parchment made with this material is found after washing to be porous, because the acid has destroyed the wood pulp, preventing its passage to the fibers beneath. It is also an important fact, which must not be overlooked, that when the raw paper is surface-glazed the acid is absorbed with difficulty. It is therefore found necessary not to calender the web of raw paper too much when preparing it for thick parchments, and for the thinner kinds to avoid the calendering altogether.

Bleached straw cellulose can also be used as a raw fibrous stock for parchment making. It is found to give it a transparent appearance. Linen fibers, on the contrary, render the parchment opaque. Half stuff, which has been quickly prepared, also produces the same effect. Great care must be exercised in the preparation of endless rolls of parchment from paper composed of these fibers.

Vegetable parchment for every kind of purpose is prepared, as a general rule, with sulphuric acid. Several other reagents, such, for example, as a concentrated solution of chloride of zinc, have been used, but good results are not so easily obtained with them as with sulphuric acid. Moreover, nearly all other reagents which have been proposed are more costly than this acid. The method of manufacture consists in simply passing a sheet of bibulous or unsized paper through a bath of vitriol, which transforms the fibers or cellulose composing the paper into a skin-like membrane resembling a bladder. Hence the origin of the name.

So perfect has this manufacture become at the present time that some kinds of thick vegetable parchments, viz., those used in bookbinding, can scarcely be distinguished from animal parchment. It is, *par excellence*, grease and water proof; but, owing to the demand for such papers, several kinds of imitation vegetable parchments are manufactured now in vast quantities, which, although they differ very widely in many features from the real article, yet possess some properties in common with it which enable them to replace it in many directions. Vegetable parchment, for example, does not fall to pieces when immersed in water, but retains its tough, pliable nature and regains its original strength when dried again. On the contrary, the so-called imitation parchment is easily torn when damped, and therefore, for wrapping up butter, fish, etc., is not so suitable. Indeed, vegetable parchment is applicable to a hundred and one uses for which the imitation kind is wholly unsuitable.

THE MANUFACTURING PROCESS.

The machine used for conveying the roll of bibulous paper through the several troughs is constructed of materials which will resist the corrosive action of the sulphuric acid. In general arrangement it is not unlike an extensive tub sizing apparatus, with this difference, that the web, after passing through the acid and other troughs, is cleansed with water as it passes over a platform of wooden rollers. These and all other rollers are driven with ordinary belt gearing in the same way as a paper machine. The trough-containing the sulphuric acid is the first of the series, and is immediately followed by another which contains dilute acid after the process of parchmentizing has been going on for a short time. These troughs are made of wood and lined with sheet lead. The rolls for guiding the paper through them, some of which are submerged in the liquids, are made of glass or porcelain, or some such acid-resisting material, while the press rolls, placed above the troughs, used for gently squeezing the excess of acid from the web, are made of a special kind of India rubber. These rolls, as may be imagined, are expensive, and on that part of the machine where it becomes possible, viz., where the washing begins, they are substituted with hard wooden rolls. The washing is usually effected by directing jets of water from a series of spray pipes, placed at equal intervals along the machine, but running across the web of wet parchment. These water pipes play upon the top and under surface of the parchment, the latter being supported by a platform of wooden rolls as mentioned above. Beneath each washing platform a large wooden trough is placed to receive the slightly acid (or alkaline) wash water, and at the further extremity of each trough a pair of press rolls presses the excess of water from the sheet before it passes on.

After the web of paper has passed through the acid bath, squeezed and partly washed by passing through a water trough and over the first washing platform of rolls, it would still retain a very large amount of acid, and if this acid were left in the parchment, rapid destruction of the product would follow. For many years, however, the acid thus left in the parchment at this stage of its manufacture has been neutralized with ammonia. For this purpose an ammonia bath, consisting of a small wooden trough containing diluted ammonia, is placed between the first and second washing platforms or troughs. It contains a submerged roll, under which the parchment passes to thoroughly saturate it with alkaline fluid. The parchment, after traveling through it, runs over a roller placed above the level of the liquid, and from thence into the water of the next washing trough, into which it simply dips, and then, passing upward, travels over the horizontal platform of rollers, where it is further washed on both sides with the water sprays. At this stage the web is tolerably clean or free from ammonia salts, but to be perfectly sure that this is so, it is again pressed between a pair of small rubber rolls to partially dry before it is plunged into the next washing trough in the series. It then passes over another platform of rollers as above described, and, finally, again pressed to get rid of the excess of water before it is dried on the drying cylinder.

The drying cylinder (sometimes more than one is employed) is constructed in the same way as those of an ordinary paper machine, the wet parchment being held against its surface by the aid of a felt. There is also a pair of glazing rolls with which the parchment is glazed before it is reeled.

The first operation in the manufacture of the parchment is passing the prepared paper through the acid bath. To do this successfully and easily it is necessary to have proper arrangements for filling and emptying the acid bath. The oil of vitriol or sulphuric acid is usually mixed to the required strength in a separate vessel, where it is stored ready for use, and from which it can be conveyed by gravitation to the working bath on the machine. This store tank is sufficiently large to hold a good supply of acid. The acid is mixed by hand; and as its specific gravity should be maintained at a constant figure, owing to its hygroscopic nature, it should not be allowed to remain exposed to the air for any length of time. In some works, pumps of special construction are used to convey the acid from one vessel to another; but this is said to be a costly and unpleasant method.

The oil of vitriol prepared for the acid bath should possess a sp. gravity of 1·636 (127° Twad. or 56 Baume), and be uniformly mixed. This acid contains, substantially, 72 per cent. real anhydrous sulphuric acid and 28 per cent. of water. Ordinary 80 per cent. (145° Twaddell) oil of vitriol may be used to make the mixture, but in every case special attention must be paid to its temperature before it is run down to the acid bath. This should never be allowed to exceed 62° Fah. (17° Centigrade), otherwise its action upon the paper is too severe. It is sought in actual practice to keep the acid as cool as possible, and to avoid rapid changes of temperature. To accomplish this conveniently, many different schemes are in vogue. Some makers, in order to regulate the temperature, and to insure that the acid is cold, pass it through a pipe immersed in a stream of cold water, while others introduce cold water coils of lead pipe in the store tank and also in the working bath. In any of these cases the temperature can be regulated sufficiently well, provided the supply of cold water is efficient.

It is usual, however, to make the acid a little stronger to begin with, viz., 1·665 sp. gr., in order to make allowance for its hygroscopic properties, etc. To ascertain whether it acts well, the workman draws a piece of the raw paper through it while in the bath on the machine. By experience he can tell if it is in proper condition. If the raw paper has been well made and of good quality, and all other conditions in proper order, little difficulty will be experienced in passing the beginning of the endless roll through the acid bath and over the other parts of the machine. It would be difficult for the novice to tell whether he was bringing forward good paper or making parchment which was quite unsalable. The experienced parchment maker can, however, tell what it really is whenever it leaves the acid bath. With this specialty it is not as in other papers where the machine plays an important part in

their manufacture. Success lies more in the direction of the condition and quality of the raw paper and acid mixture.

Obviously it is of the highest importance to apply only as much of the acid as is necessary for the preparation of a good product, because in this there is great economy. Care is therefore taken not to use more acid than is absolutely necessary to yield the desired result. The paper as it unrolls from the reel dips into the acid bath, and after the excess of acid has been scraped and squeezed from it, it passes into the first washing trough, at an angle of about 60°. The wash water contained in this trough very soon becomes strongly acid, and on the score of economy is preserved to be concentrated for reuse. It is also apt to become hot, owing to the fact that sulphuric acid generates heat when diluted with water; care must consequently be taken that the temperature is kept low. Many works intercept a part of the working acid in the second and third troughs and reconcentrate it in leaden pans, but it depends upon the proportion of acid thus caught and its strength, as well as upon the cost of fuel and the situation of the works, whether such a system of acid recovering pays or not.

The speed of the machine is also of great importance. This should be maintained at a uniform rate of speed, otherwise the parchmentizing, washing, and drying are somewhat uncertain. The level of the acid, too, in the acid bath is maintained constant, so that when the speed of the machine is once fixed, the depth to which the paper passes into the bath is a measure of the time given for parchmentizing.

There are many other points to which attention should be paid when drawing the raw paper through the acid. This work is greatly facilitated if the reels are free from faults and otherwise perfect. The presence of moisture in the paper, or water getting into the acid bath, causes much trouble. Many stoppages are caused if the web is not continuous, and if any broken pieces are made during the parchmentizing process or in the subsequent washing, neutralizing, and drying, etc., these result in a serious loss, as they cannot be worked up again like "broke" in ordinary paper mill practice. When the sheet of paper passes equally through the acid, the washing sprays are allowed to play equally upon both sides of the sheet, and if the machine is not arranged so that this can be done efficiently, the faults produced cannot afterward be removed. The paper must be treated in accordance with its thickness and breadth, and this can alone be properly done by the experienced parchment maker having a thorough knowledge of the nature and peculiarities of the raw material and condition of the machine he is working.

The web of parchment, after passing through the ammonia bath, is slightly alkaline, the whole of the acid being "killed" by the ammonia. It is only necessary, therefore, to insure that it is thoroughly washed to get rid of "fixed" ammonia salt (*i. e.*, sulphate of ammonia) and a little free alkali before it is finally dried and glazed. A copious supply of water is therefore used to thoroughly cleanse the parchment at this stage, and after excess of water is squeezed from the sheet by a pair of rubber press rolls it passes over the drying cylinder, then through a pair of iron glazing rolls before being finally wound on a reel. The prepared parchment is then cut up into suitable sized sheets and placed on the market in reams.—*Chemical Trade Journal.*

MARSHALL'S PAPER PULP FINISHER.

SINCE the invention of the Dutch cylinder stuff engine for the finishing of paper pulp the principle of the work has scarcely varied.

Whatever be the changes introduced into the construction of beating apparatus, the course of the fibers is always longitudinal in them, by reason of the natural law that forces every floating body to take this direction. The drawing action of the roller of the engine further favors such longitudinal motion. It naturally follows therefrom that the fibers present themselves at right angles to the cutting surfaces, and this has the effect of chopping them rather than of opening them or separating them longitudinally. Such inconveniences manifest themselves particularly if the apparatus is not regulated by a skilled and careful workman, if the pulp does not remain long enough in the engine to undergo the crushing effect of the roller and if the fibers are not reduced through friction between each other.

Numerous arrangements have been invented for preventing the fibers from being cut rather than crushed and for effecting the separation of them, but none of them has completely answered expectations.

The Gould type, with vertical disk revolving upon a horizontal shaft, is the one that comes nearest to attaining the object proposed, in the sense that the fibers present themselves in a direction much more parallel with the comminuting surfaces than they do in other apparatus; but the objection made to it is the excessive consumption of motive power and the impossibility of employing it for dissolving dry sheets of waste paper.

Mr. Marshall has taken up Gould's idea and has at the same time borrowed from the Jordan engine its conical part, not without providing it with some improvements. Upon combining these two arrangements, he has been led to create a new triturator, which not only performs the role of a finisher, but also completes the process of comminution, so that the finishing and mixing are effected by a single passage through the machine.

The disk, imitated from Gould's last type with its counterpart, presents a wider surface of trituration than the conical part and is designed to separate the fibers longitudinally, that is to say, to open them or pull them apart. The large quantity of work absorbed by the Gould apparatus is reduced in a large measure by the suppression of the friction of a considerable weight of pulp projected in a few seconds against the sides of the old apparatus, and which took about 70 per cent. of the power employed.

The new finisher is represented in the accompanying figures. Its conical and fixed box, A^1, is provided in the interior with about 230 bent steel blades with intervals filled with hard wood liners. These latter are formed of three thicknesses of glued wood, thus facilitating their hollowing in measure as the steel blades wear away. At the wide extremity of the cone, and upon its circumference, is screwed a disk, B^1, capable of being brought near to or removed from a movable plate by means of a hand wheel, B^2. The vertical surface of this disk, which is about 1·10 meter in diameter, is provided with 210 bent steel blades, 12·5 millimeters distant from each other, with intervals filled with hard wood.

In the conical box, A^1, and opposite the disk, B^1, revolve respectively the cast iron cone, A, of the same form and the disk, B, both keyed to the forged steel shaft, S, which is 150 millimeters in diameter and makes 300 revolutions per minute. These rotary parts are carefully balanced in order to prevent any jarring. The first carries upon its surface 72 longitudinal straight steel blades, whose interspaces are filled with hard wood. The same is the case with the second, which, placed at the extremity of the revolving cone, is provided with an equal number of straight and thick steel blades radiating around the shaft, and separated also by wooden liners.

The parts of the shaft passing through the stuffing boxes of the two extremities of the machine, like those that are exposed to the effects of the oxidizing substances contained in the pulp, are protected by bronze collars, easy to replace. The blades are made of first class steel suited to the quality of the pulp to be worked, and can be easily renewed after they have become worn.

The hand wheel, B^3, placed at the extremity opposite the driving pulley, serves to regulate the space between the blades of the box, A^1, and of the cone, A, while the lateral handwheel, B^2, permits of modifying the interval between the disks, B and B^1, according to requirements.

After being prepared in an ordinary finisher, the pulp is introduced into the apparatus through an aperture near the small base of the box, A^1. It circulates between the two cones under the action of centrifugal force and the suction caused by the two disks, performing the office of a pump, and then passes between these disks and makes its exit through a conduit situated upon the cap, C, that covers these latter at the wide extremity of the cone.

Between the two cones of this apparatus the pulp undergoes the final finishing. It is brushed therein or elongated according to the degree of proximity of the blades, while the object of the two disks is more especially to open and separate the fibers.

The work is done in a continuous manner. The pulp traverses the apparatus in eight seconds and makes its exit therefrom as perfectly fine paper stuff.

According to data communicated to us by Messrs. Everling & Kaindler, of Paris, the apparatus is constructed in three models, characterized by the following features:

	No. 1.	No. 2.	No. 3.
Space	3·75 × 1·30 m.	3·35 × 1·50	2·75 × 0·95
Production per hour	550 to 650 kg.	400 to 450	270 to 325
Surface of trituration.....	2·25 m².	1·35	1·11
Power	40 horse	30	20

An ordinary engine, occupying a space of 4·25 m. × 2·10 m. possesses a surface of trituration of only about 25 dm². A comparison of these figures with those given in the preceding table at once shows the superiority of the Marshall finisher. Besides, while furnishing a pulp of better quality, it responds to the present needs of intensive production. The work of manufactories is tending more and more to become continuous, that is to say, to no longer be divided into a number of operations independent of one another. It will finally become so in the finishing of pulps, if not in all manufactories, at least in those that make large quantities of paper of the same kind. Apparatus of great capacity and operating continuously will finally be substituted for the small engines. The hopes founded upon the future of the Marshall finisher are so much the greater in that it is adapted to all kinds of pulp and especially to bisulphite pulp, which it well prepares for felting on the machine and for calendering.—*Revue Industrielle.*

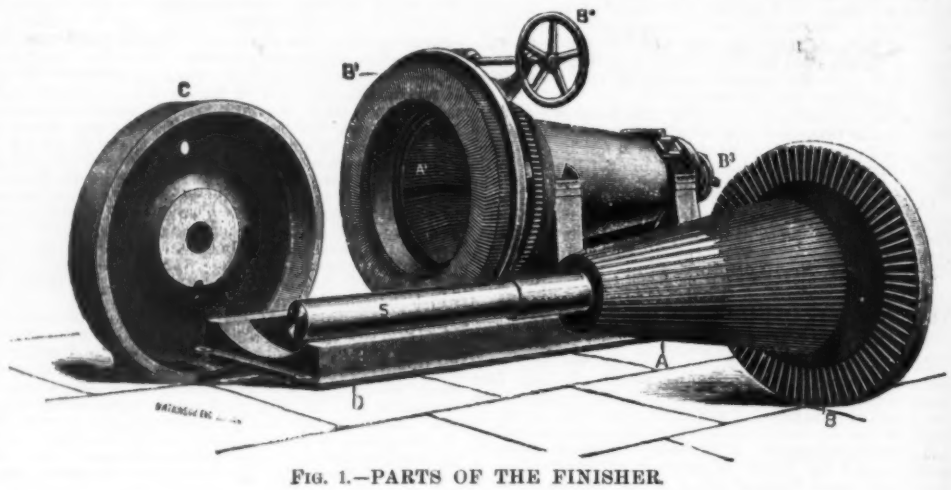


FIG. 1.—PARTS OF THE FINISHER.

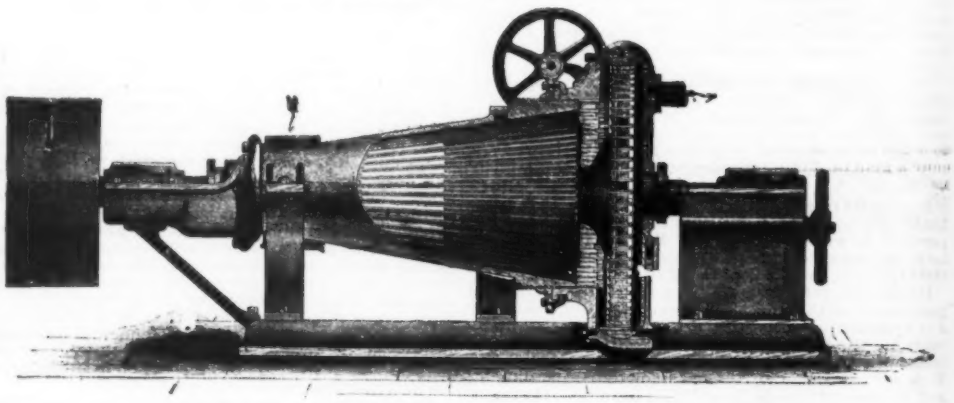


FIG. 2.—LONGITUDINAL SECTION AND ELEVATION.

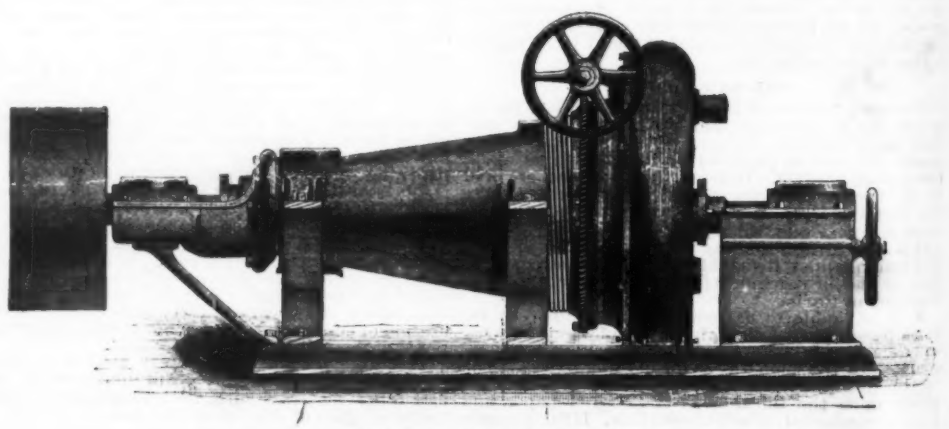
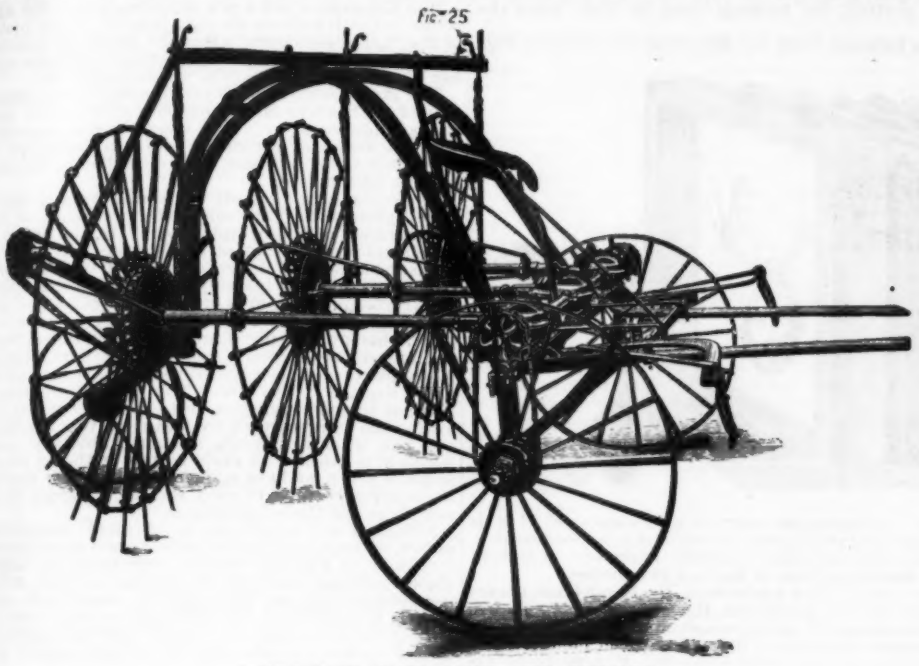


FIG. 3.—ELEVATION.

MARSHALL'S PAPER PULP FINISHER.

IMPROVED HAY RAKE AND TEDDER.

WE give a view of Stoddard's hay rake and tedder, as shown at the Chicago Exhibition, and which especially attracted the attention of foreign visitors. The *Engineer*, London, produced this engraving. The machine is a great labor saver, while, by the thorough and uniform manner in which it turns the grass, it not only hastens the time of curing, but insures excellence



IMPROVED HAY RAKE AND TEDDER.

in the quality of the hay, so far as good curing can contribute to that result.

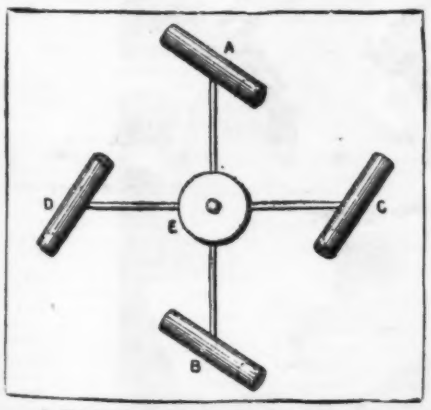
A PERPETUAL MOTION OF THE EIGHTEENTH CENTURY.

THE search for the impossible perpetual motion, which has captivated so many minds and turned so many heads, was the starting point of a fraud much in vogue and very popular toward the end of the eighteenth century. This deception, executed by certain none-too-scrupulous prestidigitators, responded then to quite a general preoccupation and met with the same success that is at present obtained by the so-called mind reading, which seems to correspond to the serious researches made upon hypnotism.

The experiment was executed as follows:

To the wall was fixed a center or disk of wood, E, capable of revolving upon a pivot and carrying four rods placed at right angles. Each of these rods terminated in a tube, A, B, C, D, slightly inclined, closed at the extremities and containing a leaden ball. The apparatus having, according to the assertion of the exhibitor, to revolve constantly of itself, was held by a string, and, when this latter was removed, it set itself in motion, stopping if the finger or any other obstacle was interposed between the branches, and resuming its rotation as soon as the obstacle was removed.

The inventor explained his discovery as follows: "The balls, A and B, are in equilibrium because they are at an equal distance from the vertical line that passes through the center, E. By the construction of the machine, the ball, D, being, on the contrary, more distant from the point of support than the ball, C, must prevail over the latter and break the equilibrium. It must then descend to the point, B, and cause the apparatus to make a quarter revolution. Now the latter cannot take place without the rod, A B, which was situated vertically, assming a horizontal position, and then the balls, A and B, are to each other



A PERPETUAL MOTION OF THE EIGHTEENTH CENTURY.

as were the balls, D C. One must overcome the other and cause the apparatus to make another quarter revolution. This second quarter revolution cannot take place without being followed by a third, through the new position assumed by the balls, A B, etc. The machine is, therefore, so constructed that it must revolve continually until the pivot is worn out and it falls through want of support."

This fine theory, which the slightest examination reduces to naught, was, nevertheless, accepted by the spectators. They could not call it in question on seeing the result before their eyes.

If the spectators had been able to examine things closely, they would have seen that the apparatus did not revolve alone, and they would have perceived one of the means employed, which were numerous. The simplest consisted in causing the apparatus to revolve through the partition, either by means of an endless cord or a belt fixed to the pivot passing through and extending beyond the partition, or by means of a magnet (if the apparatus was small and the partition thin) acting upon a piece of iron placed in one of the tubes. When the apparatus was alleged to be tied up, the person concealed behind the partition remained immovable; but when the apparatus was freed, he moved his magnet circularly or acted upon the belt, and the motion was perpetual—until the spectators had made their exit!—*La Nature.*

NEW ELECTRIC TRAMWAY CAR.

THE reception given by the public to the electric cars that are doing regular service on the lines from Saint Denis to the Opera House, and to the Madeleine, belonging to the Compagnie des Tramways de Paris et du Departement de la Seine, is very favorable, and so the company has accepted the offers that have been made it for the use of electricity upon certain of its other lines. For the last six months it has been making some experiments, especially with an electric car constructed for the line from the Porte Clignancourt to the Bastille. The system of propulsion experimented with is based upon the use of the Laurent-Cely accumulators. While in the Saint Denis automobile cars recourse is had to two trains of gearings to obtain the proper reduction of speed between the dynamos and the axles, a simplification is here introduced that consists in mounting a dynamo directly upon each of the driving axles. It has, consequently, been necessary to give these dynamos a relatively feeble rotary velocity, since they have to make the same number of revolutions as the wheels of an ordinary tram car.

The Breguet works have obtained such a result to the detriment of the weight, and have constructed dynamos weighing 3,200 kilogrammes. These dynamos are designed to furnish 100 amperes at 100 volts, say 10,000 watts. Their inductors were suspended from the car frame by powerful spiral springs and the armature was keyed to a bronze tube traversed by the axle and carrying the latter along through an assemblage of recesses. To this effect the axle carried four projections that entered the notches of a disk keyed upon the hollow axle of the dynamo. Between the axle and the tube there were rubber rings for deadening shocks.

These few data suffice to characterize the system of electric car of which trials were made last October. In consequence of the breakage of an axle, attributed to the shock produced by a derailment, it was decided that, instead of actuating the axles directly, it should be done through a train of gearings. Mr. Garnier undertook the study of the construction of the mechanical part, and requested the Societe Anonyme de l'Electricite to construct the electric accessories according to the plans and explanations of Mr. Johannet.

The car thus transformed is ready to be submitted to new trials. We give a view of it in the accompanying figure.

As in the first type experimented with, the Laurent-Cely accumulators are placed in three compartments formed under the seats on each side of the car. Each of them contains two boxes of nine elements connected in series and consisting of 11 plates, 5 of which are positive and 6 negative, and that weigh together 192·5 kilogrammes. The compartments are closed by hinged panels that allow the accumulators to be quickly changed at the company's depot.

One of the peculiarities of the car consists in the use of a new rolling material, including two converging axles and a guiding axle constructed by the Garnier works, with a view to facilitating the passage of the vehicles on curves of feeble radius.

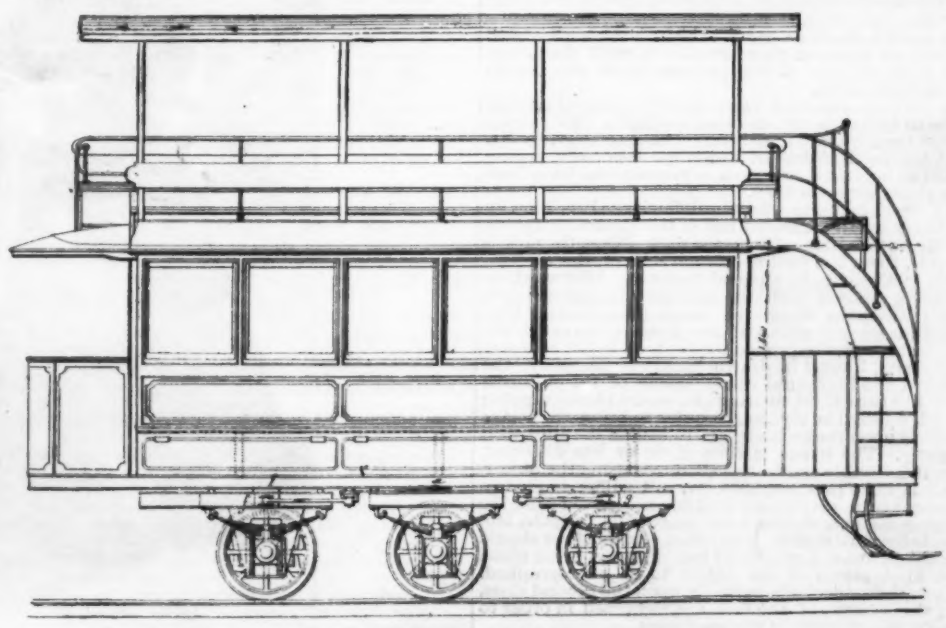
The frame of the car is supported by three independent trucks, the two end ones of which have a driving axle and the other an axle that is both a carrier and a guide. Through this arrangement, the details of which are not here shown, the passage of curves of feeble radius is very easily effected. When the car enters one of them the end trucks pivot around their axes and converge toward the central axle, which remains at right angles with the direction of the car. The front and hind trucks support the body of the car through vertical rollers arranged radially, so as to roll over circumferential bars of flat iron fixed under the frame.

In the first trials this car moved with perfect ease over curves of 12 meters radius, and in the final experiments the manifold advantages of this system will doubtless be confirmed.

In this car, as above stated, a single transformation of speed between the dynamos and the driving axles was adopted. This is realized by means of gearings established in the ratio of 505 to 104·5 millimeters. The utmost care is taken to assure a very smooth transmission of motion and consequently a large rendering. Despite the use of these gearings, a sensible saving in weight is obtained over the first arrangement. The dynamo, as a whole, with its bronze frame, weighs 1,500 kilogrammes. The excellent results furnished by steel for the polar pieces have exceeded anticipations; so it is hoped that in the future the dead weight may be sensibly reduced.

As for the arrangements of the electric material, properly so called, they have been dictated by very judicious considerations.

In the different mountings employed up to the present regard has been paid rather to the necessities of the running of the dynamos selected than to the advantageous conditions of the operation of the batteries. Recourse has always been had to dynamos in series, because they act with more security at the moment of starting, and, in general, at the moment of an increase of the resistant couple. From this standpoint they are self-regulating, the intensity of the current being always proportioned to the tractive stress. One has then been led to cause the potential of utilization of the source to vary by means of combinations in the grouping of the elements of the battery. The inconvenience of this system is striking. If, in consequence of any defect inherent to an element, the electromotive force of such element lowers, the corresponding e. m. f. of the branch of which it forms a part in a grouping in quantity lowers in the same measure. The result is that this branch, instead of furnishing its proper part of energy in the work to be effected in common by all the branches, may, on the contrary, be traversed by a current of charge coming from the other branches, which will thus be doubly supercharged, since they will have to furnish the current that the damaged



NEW ELECTRIC TRAMWAY CAR.

branch ought to have discharged, and, besides the current of recharge of such branch.

In the new mounting adopted for the car under consideration, Mr. Johannet has especially endeavored to assure the normal operation of the most delicate part of the system, the battery, save requiring of the dynamo a supplementary quick start at the moment desired, which, moreover, it will resist, if it is strong and simple in construction.

The remedy for the inconveniences above cited consists in making the battery always operate with all its elements mounted in tension, but, in return, in producing with the commutator and in the dynamos wound in derivation a variation of the magnetic field in measure with the changes of the tractive stress.

The variations of the field can be obtained either by properly grouping the elements of the inductor windings or by modifying the current of the shunt through the introduction of a variable resistance. It is the latter solution that is applied in the present case.

The commutator that permits of such variations of resistance assures, besides, the reversal of the direction of running as well as the more or less quick stoppage of the car.

To this effect, the commutator carries two dials, one of which assures the different movements to be executed in front and behind, the operation of the brakes and the closing of the inductive circuit, while the other serves to bring about the variations of the magnetic field, which, under all circumstances, corresponds to a more or less rapid operation, according to requirements.

Arrangements are made for avoiding the spark at the moment of the opening or closing of the principal circuit. To this effect, the contact key passes from one segment to the other only after meeting a series of intermediate segments corresponding to variable resistances. The same precaution is taken regarding the current of the shunt.

The entrance of the current into the armatures before the inductors are excited is rendered impossible through the use of an annex key maneuvered by the principal lever for the closing of the shunt, so that the commutator of resistance variation is not provided with an interrupter.

Finally, as every change of motion must take place in the maximum field, a special arrangement assures the automatic return of the commutator belonging to the shunt to the position corresponding to the maximum current every time the principal commutator passes upon a dead segment.

The running forward corresponds to a grouping of the armatures with the source. The same is the case with the running backward, but with a contrary grouping.

In case of damage to one of the motors, it is possible to throw it out of circuit. The other motor suffices to continue the service and carry the car to the depot.

One of the great advantages of electricity consists in the possibility of recovering, in descents, a portion of the electricity absorbed in ascents, by putting to profit the property of reversibility of the electric motor.

To this effect, the application of the brakes and the regulation on a level or on gradients are effected by employing the dynamos as generators, the motive work being borrowed from the car impelled by gravity or the speed acquired.

These generating dynamos give rise in the battery to a current of charge that increases with the intensity of the field, and thus produces a more or less rapid retardation of the car As the lines operated by electricity have very varied profiles, the stoppage through the recovery of electricity may often be usefully applied. It is, when necessary, completed by the action of the blocks of a mechanical brake of the Lemoine system that permits, under all circumstances, of mastering the behavior of the car.—*Abstract from Revue Industrielle.*

PHOTOGRAPHIC APPARATUS FOR FACILITATING FOCUSING.

THOSE who are but slightly familiar with photographic manipulations always have considerable trouble in focusing, by reason of the fact that the images of the camera are inverted upon the ground glass. Various apparatus, formed of glass plates of large dimensions placed at the back of the camera, have been devised for overcoming this inconvenience; but such arrangements, which are expensive, heavy, and cumbersome, have met with no success.

A small apparatus has just been invented that will permit an amateur photographer to right the image, and to get an idea of the clearness of all the details much more easily.

A word in the first place as to the general precautions to be taken for focusing properly. We extract these from a small treatise upon photography, by Mr. Charles de Mainbressy, which we especially recommend to beginners and even to persons who have been practicing for some time.

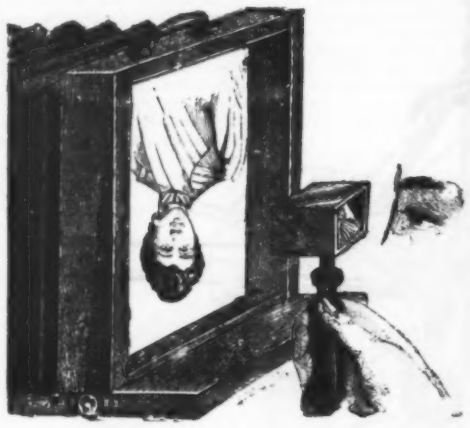
In itself, focusing offers no difficulty. It is done by moving back the posterior end of the camera by means of the button that actuates the rack. When the rack is double, there is a button on each side of the camera. This is the case in all good cameras. Afterward, on covering himself with the veil, the amateur will seek the position in which the image presents itself best upon the ground glass. If the image is too small, the apparatus must be pushed forward, or, if the contrary is the case, it must be drawn back. If necessary, the vertical and horizontal displacement of the objective may be utilized. If, for example, we are photographing a bell, we shall be obliged, in order to bring the image entirely upon the ground glass, to incline the apparatus slightly. The image is then more or less distorted, but this trouble can be remedied by raising the objective. A little practice, however, will suffice to give an idea of all the advantages that can be derived from the various motions of which the camera is capable, and we believe it useless to say that certain views should be taken from a greater or less distance, being given the diminutions of the object to be photographed. When the subject fits perfectly upon the ground glass, the three screws of the foot are tightened in order to assure the stability of the apparatus.

After this we proceed to the exact focusing, which is effected by examining the image with care and close by.

Recourse is sometimes had to the hand lens or to the ordinary watchmaker's lens, which is applied against the glass; but the use of such instruments is in nowise necessary; and it is only when it is a question of obtaining very great precision that recourse is had to them.

If the subject includes very different planes (a landscape, for example), the focusing must be done upon the objects placed at mid-distance. If it is a question of a portrait, the focusing must be done upon the face.

The focusing must be done with the objective wide



open. A diaphragm may be afterward used if it is judged that the sharpness obtained is not sufficient.

After the focusing has been effected, the button that fixes the pinion to the rack is tightened.

We owe to the kindness of Mr. Mendel, the manufacturer of the apparatus, the accompanying figure, which shows the arrangement and dimensions of it. It consists of a special flint glass prism mounted in a frame and provided with a handle. It permits of examining the image, right end up, in all its details. It may be employed with a camera of any form whatever. As may be seen, it has the form of a hand lens with all the convenience thereof. Light and not very bulky, it can easily take its place among the photographer's paraphernalia. The delicacy of the image seen through this apparatus is in nowise altered. It is indispensable for portrait and landscape taking. With it, ridiculous poses may be avoided and one will be able to judge of the artistic value of a negative immediately. —*Le Naturaliste.*

MISS KLUMPKE.

WALKING in the footsteps of Sophie Germain, Maria Agnesi and Madam Kowalewska, Miss Klumpke, a young American woman, of San Francisco, has devoted herself with talent and success to the study of mathematics, and obtained the degree of doctor of sciences on the 14th of December, 1893.

It is in its application to astronomy that Miss Klumpke has made mathematics a study. Two other young ladies, Misses Bignon and Leblois, had already received the degree of doctor of sciences, but it was the natural sciences that they had made their specialty.

We must not be surprised, however, at the success obtained by young women, in mathematics especially. The female brain, according to the opinion of physiologists, is peculiarly adapted to the study of the exact sciences, and it is by reason of usages and traditions much more than through want of aptitude that examples of the kind that we have just mentioned are not more numerous.

Miss Klumpke is not a new comer in science. She was connected with work on the equatorial in the east tower of the Paris observatory, when the lamented Admiral Mouchez, struck by her very peculiar aptitudes and her high degree of education, distinguished her.

The staff was then employed in making an accurate map of the heavens in utilizing the most recent processes of photography. Miss Klumpke was connected with the work and introduced into it a perfection of researches and a precision that immediately brought her into prominence.

Our engraving represents the young woman doctor in her office at the Paris observatory working at the measurement of photographic negatives, the union of which will form the map of the heavens. In front of her is the apparatus designed for such measurement. It is a large, highly magnifying microscope, strongly constructed of cast iron in order to prevent any shaking or other motion. Its role is as follows: In the first place, photographic plates are selected, and upon them an impression of regularly spaced crossed lines is taken. These plates are then exposed to the heavens twice for about a quarter of an hour. The heavens are photographed thereon, and then, instead of laboriously following the stars in space by means of the telescope, one has, after a manner, an immovable sky, upon which it is possible at one's leisure, with the microscope of which we have spoken, to determine exactly the relative position of each star with respect to its neighbors and the constellations.

Although the apparatus is of great magnifying power, we may judge of the patience and sagacity that it requires to register without error upon the plates these small stars scattered at random and almost imperceptible, and not to confound them with each other. It is here that Miss Klumpke excels. She has already furnished our astronomers with the confirmation of certain scientific hypotheses and opened new vistas.—*L'Illustration.*

MISS KLUMPKE, DOCTOR OF MATHEMATICAL SCIENCES.

NOTES ON THE TREATMENT AND CURE OF CANCER.

By NICOLAS PIKE.

THE IMPORTANT DISCOVERY OF THE TREATMENT AND CURE FOR CANCER.

THE medical profession all over the world are giving their attention to the new treatment for cancer and kindred disease by inoculation with erysipelas, as they consider it of great importance to mankind. It is now being put into practice by many skillful professional men in this country and in Europe, and where it has been tried carefully success has been the result. We know of a long-standing case yielding after short treatment, and is now supposed to be entirely well. The importance of this cannot be too highly prized, as the disease until recently has baffled the skill of some of the most learned men of the world. It may be safely said that the medical faculty were wholly in the dark as regards *the causes* and treatment of cancer. It

seems that the disease is on the increase, as a physician informed the writer that for the past ten years the cancer patients doubled that of the preceding ten years.

More than seventy per cent. of these were women, and twenty per cent. were cancer of the breast. Of the many cases which he treated, most of them he operated upon which only gave temporary relief, the disease appearing again in a short time, and in many cases death alone relieved the patients of this terrible and hitherto incurable disease. The medical profession are not generally of the same opinion as to the cause of cancer. Some agree that it is hereditary taint, which is constitutional, others hold that it is a truly local disease. The discussion of this disputed question involves statements of a very complicated kind.

There are many who positively declare that cancers of every description, as well as those of a kindred nature, are caused by eating too much pork and meat, which contaminates the blood. Some members of the French Academy of Medicine assert that they firmly believe that the use of pork as a food is the origin of cancer; many writers of the olden times claim that leprosy, as well as cancer, were caused by eating too much of the same. Others assert that suppressed evacuations, particularly those of a gross habit, excessive fear, grief, anger, religious melancholy, a long-continued use of food that is too hard of digestion or of an acrid nature; colds, blows, friction or the like, and many of our distinguished medical writers on the subject assert that it is hereditary from parents who are afflicted with scrofula.

That the cancer is caused by eating too much animal food seems absurd, as the following statement will show. Surgeon-Major Handly, resident surgeon of the Hospital Japore, India, writes the following in the *British Journal of Medicine* in April last: "M. Reclus has shown that cancer is all but unknown among the persons whose food was exclusively vegetable!" A. Venniel also believed that the increase of cancer was largely due to the large carnivorous habits of diet of the past generation. The records of the Mayo Hospital of Japore, which is under Hendly's charge, show no such immunity of vegetarians from cancer. From January, 1880, to the present date, 102 major operations have been performed in the hospital in cases of cancer. Of these, 41 were on the persons of meat eaters and 61 on those of strict vegetarians, who had never eaten meat since their birth. In India, where caste rules are exceedingly rigid, the fact that the latter were true vegetarians is capable of absolute proof. Among them are six Saraogis, a class of Iains who always reject many kinds of vegetables. Three of these Saraogis suffered from cancer of the breast. Out of one hundred and two cases, there were three deaths attributable to the operation. There is no information available as to recurrence of the contrary. The cases were divided as follows: Cancers of the breast, 20; tongue or lips, 8; head and face, 17; upper extremity 11; lower limbs, 8; trunk, 18; testicles, 1; glands, 8.

There were sixty-three males and forty females, a large proportion of the latter in a country where the Purdah system is in force. The maximum age was 70 years; the minimum age was 18 years; the average was 48 years. Dr. Simms, of Oxford, England, some years ago discovered a medicine which he called *Oxonia*, which was said to cure cancer and kindred diseases.

The Radcliff Infirmary sent their cases to this gentleman when they were pronounced incurable; and all patients with lupus and rodent ulcers were cured by him. Mr. Thomas Christy, F.R.S., of London, was advised to test this wonderful medicine, which he did, and published the result of his experience in a small pamphlet. In his consultation with some of the medical faculty, they requested that his experiments should be put to the most severe tests. It was decided to send down to Oxford some very serious cases of lupus, which had been under treatment for ten or twelve years in the London hospitals. It was thought that this would be a test and settle the question at once. In less than two weeks one man, who had two *perforations* in the cheek and one in the neck; these had all filled up, and the flesh was quite sound, and has remained so for some months without any recurrence. The particulars of this case have been recorded. This medicine has been distributed to some of the most eminent surgeons and medical men in England, who have tried it, and in every case where it has been carefully used it has given great satisfaction. It is now in general use in the London hospitals, and many surgeons positively assert that they are certain, and now able to cure cases of lupus and rodent ulcers very quickly. Sores on the surface or on the nose can be cured in a few days.

Mr. Sydney Turner, F.R.S., and Dr. Plummer, two gentlemen who have been appointed as commissioners to study the cancer and its causes; that they have arrived at the decision *that cancer is entirely produced from external causes*, although several people have put in opposition to this theory at every *post-mortem* examination since, the same conclusion has been arrived at, and they have proved by careful research that, although the cancer may have been in the inside of the body, they have found the original seat of the wound. This thoroughly corroborates the opinions of Dr. Simms, of Oxford, who has held this view for some time, and, acting in accordance with that, has cured numerous cases in all forms by external use. The result of this discovery will in all probability revolutionize the mode of treatment of this and kindred diseases throughout the civilized world. It has been stated that a cancer patient in the New York Hospital was accidentally inoculated with the virus of erysipelas, and, as the disease progressed, it was noticed that the patient's cancerous condition improved. This fact suggested to the physician in charge the importance of inoculating other patients with the erysipelas virus. Several were set apart, and experiments were begun and carried out.

The inoculation of patients with "carcinoma," commonly known as cancer, also on others who were suffering from "sarcoma," which is a more malignant form of tumor than the ordinary cancer. The results were satisfactory. Dr. Bull has stated that there is not sufficient evidence to warrant in saying that the use of erysipelas virus of cases of cancer, excepting as a makeshift. All that has been gained is the confidence that the virus of erysipelas is antagonistic to and would effect a cure in cases of sarcoma, and that it would be a justifiable remedy in such malignant troubles. Sarcoma, a soft, fleshy tumor, is quite as obstructive to life as cancer, but not by any means so frequent. So far as this application to cancer is concerned, the results have been encouraging. They have relieved many patients, but the results did not warrant any such statements as have been extensively circulated through the country. The treatment of erysipelas for the cure of cancer and kindred diseases is not new. It has been experimented with by numbers in Europe. Dr. Babtchinsky, a leading physician of St. Petersburg, Russia, discovered the antagonism which exists between the diphtheria microbe and that of erysipelas in a patient suffering with diphtheria, caused a speedy cure of the latter. Six children were stricken almost simultaneously with diphtheria in one family; five of them were inoculated with erysipelas bacillariæ, and they recovered in a wonderfully short time. The sixth child had been at once removed to a remote part of the city, and died of the dread epidemic. It has been stated later that the doctor has also been successful with erysipelas virus in cancer and kindred diseases. The progress of the erysipelas is a painless and quiet one, not accompanied by unfavorable results upon the general condition of the patient while the cure is being effected. If they have found the real enemy of the cancer and diphtheria, the medical profession will wipe out a foe which demands annually thousands of living beings. Further clinical experiments with erysipelas virus will have to be made before the method of inoculation is employed indiscriminately.

This disease is not confined to the human family, but has been noticed among some of the lower order of animals, such as the dog and cat. We once saw what was supposed to be an ordinary tumor under the chin. It was removed by a veterinary surgeon successfully. After the operation and upon examination it was found to be a true cancer which appeared again during the year, and was the cause of the dog's death. The dog and the cat are more subject to it than some other animals. The horse, mule and pig are next in frequency. It has not been observed in birds, fish or reptiles, and is not transmissible.

THE DANGEROUS EMPLOYMENTS INQUIRY.

THE Departmental Committee appointed by Mr. Asquith to inquire into the conditions of labor in the chemical, white lead, and allied industries have issued their report.

The committee were directed by the Secretary of State to inquire (1) into the conditions under which lead smelting, the working of blue lead, and the production of white lead, red lead, yellow lead, and litharge are conducted, with the object of diminishing any proved ill effects on the health of the work people engaged therein; (2) as to whether the special rules which already exist with regard to the manufacture of white lead are sufficient; and (3) to suggest any precautions necessary to the industries specified for the protection of life or health.

The inquiry was extended into England, Scotland, and Wales, and the committee visited 46 works and examined 184 witnesses. The reports on those industries of special interest to our readers are as follow:

White Lead.—The institution of a medical examination previous to the employment of females; the requirement of a medical certificate after absence through illness, before re-employment, for both sexes; tho prohibition of females under 20 years of age from employment; the requirement of a certificate of birth or baptism, or other proof of age, for females before employment; the reduction of the price of such certificate to not more than 6d.; the abolition of female labor in all processes where there is direct contact with white lead—*i. e.*, white beds, rollers, wash becks, stoves, and packing; the adoption of the overalls and head covering for females in the blue beds and all parts of the works; the provision of shoes and stockings for all females employed, and the enforced wearing of these during working hours; the provision of a hood connected with a fan for packing and storing dry white lead; the provision of a dining room; the provision of a standpipe or hose in the white beds.

Red and Orange Lead.—The prohibition of the use of the rake in drawing charges of massicot, or of red lead, or of orange lead, from the furnace; the prohibition of such charges being drawn from the furnace on to the floor of the workshop or factory; the prohibition of packing massicot, red lead, or orange lead, in the same place where its manufacture is carried on; and the provision of a hood, connected with a fan, for packing massicot, or orange or red lead; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the institution of a weekly medical inspection of all persons employed in such works; the provision of the prescribed drink.

Yellow Lead.—The provision of fans; the adoption of respirators and overalls for all those engaged in dry processes—*e. g.*, carding yellow yarn, etc.; the provision of an adequate supply of Epsom salts and the prescribed drink; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes and towels.

Colors.—The adoption of respirators and overalls wherever dust is generated; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the prohibition of any male young person or female in such works.

Lead Smelting.—The prohibition of females and young persons from employment in cleaning the flues; the adoption of respirators and overalls for those employed in cleaning the flues; the prohibition of any one working more than two hours in the flue at a time; the requirement that every one employed in cleaning the flues must take a bath before leaving the works; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes and towels.

Enameling of Iron Plates.—The institution of a medical inspection of all employes at least once a month; the prohibition of females under 20 years of age from employment in a brushing room; the institution of a medical examination previous to the employment of females; the requirement of a medical certificate after absence through illness, before re-employment, for both sexes; the provision of half a pint of milk and a biscuit for each female employed before beginning work; the provision of a fan to each perforated table or bench; the provision of a dining room and a cloak room.

The Tinning and Enameling of Iron Hollow Ware.—The provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail brushes, and towels; the requirement that every one employed must wash face and hands before meals and before leaving the works; the prohibition of taking any meal in any part of the works except in an apartment provided for the purpose; the provision of a dining room.

To Apply Generally.—The substitution in all copies of special rules for the words "as to persons employed," of the words "duties of persons employed;" the extension to cases of lead poisoning of the same usage as obtains in cases of accidents—namely, a compulsory report to Her Majesty's inspector of factories and to the certifying surgeon for the district.

The following suggestions are added:

White Lead.—The treatment of the washing water from the first tank below the rollers so as to render it free from acetate of lead in solution, or the prohibition of the immersion of the workpeople's hands into this liquid; the provision of food for the operatives; the postponement of the abolition of female labor in processes where there is contact with white lead until January 1, 1896; the adoption of mechanical means for stacking, stripping, drying, and packing white lead; the discontinuance of wearing gloves for manipulating white lead; the adoption of the cambric, bag shaped respirator; the postponement of stripping white beds until they are "mature."

Blue Lead.—The careful observance of all cases of lead poisoning which come to the notice of Her Majesty's inspectors of factories, and which have arisen in lead pipe or sheet works, in order to accumulate sufficient *data* on which to base future recommendations.

The Tinning and Enameling of Iron Hollow Ware.—The prohibition of the use of lead and arsenic in the enameling and tinning of hollow ware for kitchen purposes.

The report concludes as follows:

The committee are aware that the enforcement of some of the recommendations they have made may appear to operate hardly upon the manufacturer. But they would point out that each of these reforms is actually in force in some works in the United Kingdom. The greatest change recommended by them is the exclusion of females from all direct contact with white lead. The committee have seen four works where no women are employed in the white beds, in the stoves, or in packing. Judging from the experience they have had, they do not believe the number of women who would have to be replaced owing to this provision can be more than 600.

The committee have noticed that the works in which the largest number of cases of lead poisoning have occurred are those where there has been the least expenditure of money and care in precautionary measures for the health of the operatives.

The committee do not think that the precautionary measures they have felt bound to recommend will press so heavily upon employers as to materially hamper them. But they are agreed that in an industry attended with so much risk to life and health as the white lead manufacture, the same precautionary measures must be taken by all classes of employers as an essential to their continuance.

In making the foregoing report the committee have all along borne in mind the paramount claim of the operative, on the one hand to the protection of his health; and on the other, the possibility that, by making changes too sweeping or by insisting on too extensive an expenditure of capital, they might damage and cripple the industry so as to drive it away from the country and so cut off altogether a source of employment for the industrial classes. They are aware that if the manufacture of white lead were absolutely prohibited in the United Kingdom scarcely a ton less would be used in these islands. The competition from abroad—both from America and the Continent—is very keen; but they hardly think that the alterations in and the additions to the special rules that they have suggested will materially hamper the manufacture or unfairly handicap native enterprise; and it is to be remembered that their adoption will at all events serve to satisfy those responsible for the employment of work people in an industry otherwise so dangerous that the employment has been safeguarded by all the expedients which a prolonged and extensive inquiry has brought to light. In the future, no doubt, practical experience may lead to further endeavors in this direction, but at the present stage of scientific knowledge the committee believe that the measures they have proposed include every precaution that can be used in reason and with safety; and if these be accepted and loyally carried out by all concerned, they are of opinion that it will be long before any justification can arise for further interference on the part of the state in the management of these important industries.

Finally the committee desire to record, as the result of their experience, the fact that lead and all its compounds are in a greater or less degree poisonous, and that the handling or use of each or all of them is attended by danger.

FUMIGATION WITH BISULPHIDE OF CARBON.

By H. DU BUYSSON, Brout Vernet, France.

THE fumigating chest for use with bisulphide of carbon has been employed for many years in the preservation of unpoisoned herbaria, which would infallibly be devoured without this annual or biennial precaution. These fumigations may render great service in the preservation of other objects more useful than the specimens of a herbarium. I shall describe, therefore, the first method used, and every one will know how to apply it to his own needs.

It is in principle a rectangular box of light wood, lined with thin zinc, which is carefully soldered at all joints.

Around the edge of the box, inside, runs a little gutter of zinc, carefully soldered. This gutter is filled with water and serves to make a water seal by means of the flange of the lid, which is also covered with zinc and carries all around a strip of the metal bent at right angles, and long enough to plunge into the water in the gutter. In this way the box is hermetically sealed and the vapors of the bisulphide cannot possibly escape from it.

Botanists now generally poison their specimens, and the fumigating box is seldom used. Nevertheless, it has served me well and I still resort to it from time to time, to preserve such plants as I have not time to submit to the action of arsenic in alcohol or to bichloride of mercury.

The process in question is based upon the great volatility of bisulphide of carbon at ordinary pressure and moderate temperature. The penetration of its vapor is so considerable that we have only to pile up in the chest the mounting-sheets of the herbarium, one above the other, in order to fumigate them. They are penetrated to the very center and eggs, larvæ, and perfect insects, Anobium or Attagenus, are killed. Space should be left and right of the pile for the vessels containing the bisulphide. Those which I use are of zinc and measure 10 cm. long, 6 cm. wide, and 9 cm. deep. There is no risk in prolonging the fumigation; on the contrary, there is but the greater certainty of its being efficacious. Five or six days will be time enough. No limit need be set to the quantity of bisulphide used; what is not evaporated will serve for a new charge.

The disagreeable odor of bisulphide of carbon is not persistent; it is not even necessary to spread open the mounting-sheets; it is only necessary to expose them, unopened, to the air. I would call attention, however, to one very necessary precaution, if accidents are to be avoided. The vapor of bisulphide is very inflammable, and the chest must, therefore, be set in a safe place and not opened near a fire or any flame whatever. It would be risky, for example, to unpack the chest in the evening while holding a lamp in the hand.

As the odor of bisulphide is very disagreeable and may cause discomfort to some persons, all these operations should be performed in an attic or in an apartment of which the windows may be left open as long as necessary.

PRESERVATION OF FURS AND WOOLENS.

The same process may be used in the preservation of clothing in clothing establishments, civil or military, where Tinea and Attagenus sometimes cause such ravages. Special arrangements may be adopted in establishing fumigating chests or rooms to avoid the settling due to weight and to facilitate the penetration of the gas.

This method makes it certain that we shall not "shut the wolf up in the sheepfold." Articles fumigated are entirely rid of eggs, larvæ, and living insects. They may be shaken out in the open air for greater security and then replaced on the shelves, with the assurance that they will not be found gnawed when next visited.

PRESERVATION OF THE STUFFING OF FURNITURE AND SADDLES.

Tinea and Attagenus have a marked predilection for horsehair, so that these insects are sometimes found flourishing in the stuffing of our furniture, even that which is in daily use. This process has the advantage of permitting us to destroy them without having recourse to the upholsterer; we need but to construct a fumigating chest large enough to contain a couple of armchairs or more. In the same way we may treat mattresses, eiderdown quilts, or anything which is supposed to contain eggs or larvæ.

I have experimented with a saddle much damaged by moths, and after fumigating it five days noticed no appearance of insects; the saddle was completely penetrated by the vapor and all the moths perished. I kept it two years under observation in order to be assured of the efficacy of the process.

DISINFECTION IN EPIDEMICS.

I am persuaded that clothing subjected to this process would be disinfected quite as well as by the processes usually employed in certain epidemics, such as typhus, cholera, smallpox, etc. It seems to me that the vapors which penetrate fabrics so well and kill insects so thoroughly would act in the same way upon the microbes which engender epidemics.*—*Insect Life.*

FORMATION OF SNOW IN BRIGHT SUNSHINE.

TWO solid bodies, one of them yellow, sulphur, and the other black, carbon, unite under certain circumstances and form a colorless and very volatile liquid called bisulphide of carbon, that must be handled with great precaution, on account of its being so inflammable.

The solvent properties of bisulphide of carbon render it valuable for removing grease spots. Although its odor is more disagreeable than that of benzine or spirit of turpentine, it has at least the advantage of disappearing rapidly, in consequence of the quick evaporation of the liquid.

It removes paint from garments with the greatest facility, but not without causing considerable agitation of the mind in those who use it for the first time. At the point rubbed—at the very place where they, to their great satisfaction, saw the paint disappear, they see a large white spot appear, of the nature of which it is difficult to form an idea. The more they brush it, the more prominent the spot becomes. Has the garment been cleaned, then, only to be ruined? Fortunately, such is not the case. In a few instants the spot will have disappeared, never more to return, melted by the heat of the body. The alleged spot, in fact, was nothing else but snow.

The bisulphide of carbon, in order to evaporate, absorbed heat from the garment and from the surrounding air, and there resulted a depression of temperature sufficient to congeal the aqueous vapor of the atmosphere.

Without operating upon clothing, it is possible to show the production of such cold in the following manner:

Far from any flame and even from a hot stove, fill a very small bottle and close it with a cork stopper provided with an aperture in the center. Into this aperture introduce a piece of twisted unsized paper. This should reach the bottom of the bottle and its upper extremity should project about an inch above the cork. At the end of a quarter of an hour the free part of the paper will be seen to be covered with small particles of snow.

The liquid has ascended by capillarity through the paper, just as the oil of a lamp rises in the wick. On reaching the exterior it has evaporated, and the water

contained in the air, being suddenly brought to a temperature of 30° below zero, has congealed.

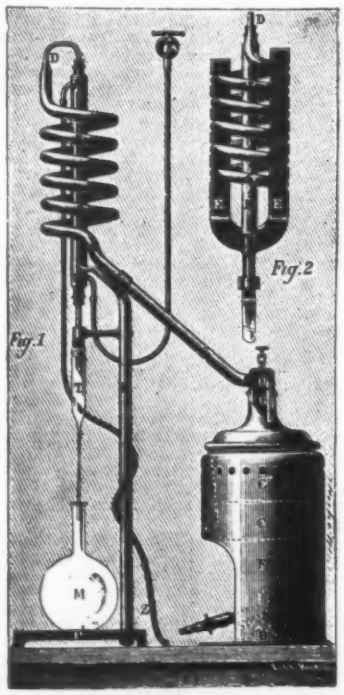
If the upper part of the paper be cut into three narrow strips, well separated from each other (for the whole becomes adherent, through the formation of ice), there are obtained serrated flowers of the most charming aspect, which may be varied in hundreds of ways.

In order to avoid the disagreeable odor of the liquid, it is well to perform this experiment outside of the room, on the edge of a window, for example. The operation can be performed in summer, in bright sunshine. The result will be only the more rapidly obtained, the production of vapor being more abundant.—*Chimie Amusante.*

DISTILLATORY APPARATUS FOR THE SEPARATION OF ALCOHOL FROM MIXTURES.

WHEN two liquids, alcohol and water mixed, have different boiling points, 78° and 10°, it is possible to separate them when they are in a state of vapor by causing them to circulate in a tube in which condensation can take place through cooling. The aqueous vapor condenses first, while the alcohol remains volatilized until it meets a colder wall, against which it liquefies in its turn, freed from the water that accompanied it. This principle, put in practice by an appropriate apparatus, permits of condensing in a small volume all the alcohol contained in a liquid. This mode of separation is called fractional. It is obtained in laboratories by means of the ball apparatus of Messrs. Lebel and Henninger, or with the Schloesing ascending worm, and in the industries by the tray apparatus.

The new instrument here represented is based upon



DISTILLATORY APPARATUS FOR THE SEPARATION OF ALCOHOL FROM MIXTURES.

the principle of the Schloesing apparatus. It consists (1) of a copper still, C, of a capacity of one liter, resting upon a furnace, F, heated either by a gas burner or an alcohol lamp; (2) of an ascending worm, S S S, of tin drawn out and curved at its upper part, traversing a refrigeratory, R R, and ending in a gauged balloon, M, the whole being supported by a cast iron plate, P; (3) of balloons gauged 1 liter and 500 and 250 cubic centimeters capacity, closed with rubber stoppers, and rigorously comparable with one another, that is to say, the one of a liter capacity having to contain exactly twice that of the balloon gauged 500 or four times that of the one gauged 250 cubic centimeters; (4) of a test glass with foot, well calibrated, capable of holding 300 cubic centimeters of liquid; (5) of two alcohol meters of 0° to 20° and of 20° to 40°, verified by the State; (6) of a thermometer showing the half degree and likewise verified; (7) of a table of alcoholmetric correction; (8) of a bottle of potash pastilles; (9) of several glass pipettes; (10) of rubber washers for the closing of the apparatus; (11) of rubber tubes for the entrance and exit of the water; and (12) of a metallic funnel.

The following is the operating method: (1) accurately measure the liquid to be distilled, in a gauged balloon, either of a liter or a half liter, the leveling being effected by a pipette; (2) decant into the still with a funnel, the balloon being rinsed several times with water distributed over the sides by means of a glass tube, and the washing water being emptied each time into the still; (3) add a few pastilles of potash up to the saturation of the acidity of the spirit; (4) connect the still with the worm by means of the coupling collar, and be sure that the rubber washer is in a perfect state; (5) pass water into the refrigeratory in such a way that it shall flow out in a thin stream upon its exit; (6) place under the refrigeratory the gauged balloon designed to receive the product of the distillation;* (7) light the burner or alcohol lamp and observe the moment at which the first drop distilled falls into the gauged balloon, and then regulate the heat in such a way that the drops shall follow each other rapidly to the bottom of the balloon without forming a continuous stream; (8) when the level of the liquid collected in the receiver is about two centimeters below the gauge mark, extinguish the burner or alcohol lamp; (9) arrest the flow of the water into the receiver; (10) with water taken up by a pipette, make the level of the liquid exactly flush with the gauge mark in the receiver, and then close with the rubber stopper, shake vigorously in inverting the balloon several times in order to well mix, and then rest until the bubbles of gas have entirely disappeared: (11) fill the test glass and slowly immerse the very clean and dry alcoholmeter until it floats of itself in the center of the cylinder; (12) when the oscillations have ceased and the instrument is immovable, proceed to the reading upon the graduated stem in placing the eye at 15 or 20 centimeters from the test glass and at the level of the liquid; (13) read the division that corresponds to the trace of the horizontal plane passing through the lower meniscus; (14) take the temperature and refer to the tables that accompany the apparatus, in order to calculate the real alcoholic value and divide the result obtained by two.

A foamy liquid can be accurately measured only after being freed from the excess of gas that it contains through agitation in a receiver of greater capacity. In order to avoid too complicated corrections of volume, it is important to introduce into the still only liquids that are not too far from the temperature of 15°. During the distillation, it is well to assure one's self that the water that leaves the refrigeratory is scarcely tepid. If the contrary were the case it would be necessary to increase the discharge. When there is no water supply in the room in which one operates, the inconvenience can be obviated by installing in a corner and above the apparatus a tubulated bottle or a cask provided at the bottom with a cock to which the rubber tube is adjusted. If necessary, the water that makes its exit from the refrigeratory can be poured back into the reservoir and be used anew; yet the colder it is the more quickly the operation is effected.

With this new apparatus one is sure of concentrating the totality of the alcohol into a volume half less, when it is a question of liquids whose alcoholic value does not exceed 20°. When one has to deal with spirituous liquids, take 250 cubic centimeters of the liquor, decant them into the still, fill the balloon anew with water that one adds to the boiler, distill and collect 250 cubic centimeters in the gauged balloon that has served as a measure. In this case the value observed is the real one, after correction due to the temperature.

All the operations are executed with a guarantee of a tenth of a degree, according to the verified experiments that have been made.

The apparatus, permitting of dividing the products of distillation, is very well adapted to the separating of the small quantities of alcohol remaining in vinasses, which is something that no other instrument would do. For certain tests, either because one has need of following the ebullition of foamy liquids or of operating upon small samples, or for any other cause, one may have to use a glass balloon. To this effect, although in all respects it is preferable not to interrupt the continuity of the worm, the apparatus may be so constructed that upon unscrewing the obturator there may be adapted in its place a rubber stopper provided with an aperture, and itself fitting in a glass balloon.—*La Nature.*

POTASSIUM.

H. DAVY, in 1807, made the momentous discovery that potassium hydroxyd, which had thus far been considered an element, can by the galvanic current be decomposed into a metal, potassium, and O and H. He employed a very powerful voltaic battery of 200 pairs of 4-inch plates, while to-day we carry out this electrolysis more easily by means of Bunsen's elements. For the production on the large scale at present a different process is applied, viz, tartar is carbonized in a covered crucible and this intimate mixture of potash and carbon is exposed to the strongest white heat. According to the equation:

$$K_2CO_3 + 2C + 3CO + K_2$$

is CO and metallic K obtained which volatilizes at this heat and is blown into a recipient which is half to two-thirds filled with petroleum in which the K accumulates without being oxidized. Potassium is a silver-white metal with strong luster which at the ordinary temperature possesses the consistence of wax, is brittle below 0° C., and melts at 58—62·5° C.; specific gravity, 0·865; voluminary weight 39. It oxidizes immediately in the air, and is, therefore, kept in a liquid free from oxygen, such as petroleum. On heating in the air it burns with a violet flame. The violet coloration of the colorless flame of a Bunsen burner is characteristic for all potassium compounds, and it is best recognized by observing the flame reaction through a blue glass.

As we have seen in the contemplation of water,

* NOTE.—I have observed in bisulphide of carbon no clearly defined power of taking out the colors of fabrics which I have subjected to its vapor. It may, therefore, be used without fear, except perhaps in the case of the most delicate tints.

* When a liter is operated upon the half liter balloon is placed, and when a half liter is operated upon the 250 cubic centimeter one is placed.

potassium decomposes water with extraordinary energy under liberation of H, which ignites and by the volatilized K burns violet gray.

Of the potassium salts are, besides potash, only tartar, potassium bichromate, potassium permanganate, alum, the prussiates and tartar emetic of interest for the dyeing and bleaching industries; but as the active principle of these potassium compounds does not dwell in the K, they must be reserved for future consideration at the proper places. Potassium hypochlorite, which, under the name of eau de javelle, is known as bleaching liquid for vegetable dyestuffs, requires no special consideration, since it is for bleaching technics much too dear, out of the question.—*Textile Colorist.*

THE FORMENEPHONE FOR THE MUSICAL ANALYSIS OF GASES.

IT is under the above somewhat strange title that we are going to present to our readers an absolutely new principle of analysis, which permits of determining the quantity of a foreign gas contained in the air by means of the sound produced by the gaseous mixture in passing through sonorous pipes. It is to Mr. E. Hardy, one of our most distinguished physicists, that we owe this original discovery. The learned experimenter first applied it to the search for fire-damp in coal mines. We shall describe the apparatus that he has constructed, but shall first give a succinct historic *resumé* of the researches that have been made in order to ascertain the presence of fire-damp in mines.

Every one knows the terrible catastrophes that fire-damp so often causes in coal mines. Fire-damp is, as well known, composed essentially of formene or marsh gas. This is the gas that disengages itself from the mud of stagnant water when a stick is thrust into it. Mixed with air in the proper proportion, it detonates violently in contact with an ignited body. In order to combat fire-damp, we have ventilation only. On sending a large quantity of air into a mine, we dilute the fire-damp and carry it to the exterior. In order to prove its presence, we have only the aureola that

FIG. 1.—HARDY'S FORMENEPHONE IN OPERATION IN A COAL MINE.

it forms around the flame of lamps. This aureola appears around the flame of ordinary lamps only when there is already 3 or 4 per cent. of fire-damp mixed with the air, and then danger is approaching. It is true that improved lamps exist that are designed for the detection of fire-damp, but we always forcedly remain, with the aureola, in the presence of an appreciation of a phenomenon difficult to seize. Moreover, as fire-damp collects at the top of the galleries on account of its lightness, the height of the chimney of such lamps prevents researches being made at the places where they would be most necessary, for the fire is often seen running at the top of the galleries like a train of gunpowder, and threatening a catastrophe if it happens to reach regions where the proportion of fire-damp is a little larger.

There exist also very accurate scientific apparatus,

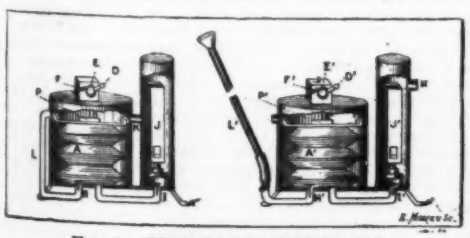


FIG. 2.—THE FORMENEPHONE.

A A', bellows; B B', cords winding around the crank shaft; D D', H H', I I', valves; L L', suction pipes; J J', organ pipes; E E', ratchet wheels; F F', clicks; D D', cranks; P P', weights.

especially the Coquillion fire-damp indicator, improved by Mr. Grehant, for measuring the quantity of the gas existing in the air, but they are too delicate to be used outside of the chemist's laboratory, and, moreover, require a certain length of time (nearly twenty minutes) for making a verification.

Mr. E. Hardy, as we have said, has just devised a very original and certain method, as well as an apparatus called a formenephone, designed to make known in a few seconds the presence and the quantity of fire-damp or of any other gas mixed with the air.

The following is the principle upon which the formenephone is based: When we cause two organ pipes of the same pitch to sound at the same time, by means of two distinct bellows supplied with pure air, we obtain a single sound. All being thus regulated, if one of the bellows, instead of being supplied with pure air, be supplied with a mixture of air and a gas not having the same density, the sound of the corresponding organ pipe will be modified, and the two pipes sounding at the same time will give more or less frequent vibrations, according as there is more or less foreign gas mixed with the air.

With a little practice one can easily estimate the quantity of it approximately. In fact, the organ pipes giving the *ut*[1] and the gas mixed with the air being formene, we obtain the following results:

For 1 per cent. of formene in the air, we have about 1 vibration per 3 seconds.

For 2 per cent. of formene in the air, we have about 3 vibrations per 2 seconds.

For 3 per cent. of formene in the air, we have about 2 vibrations per second.

For 4 per cent. of formene in the air, we have about 3 vibrations per second; and so on, the vibrations increasing in frequency in measure as the gaseous mixture becomes richer in formene. When it reaches 12 per cent., we have about 9 vibrations per second. At 20 per cent. they become very frequent, and at 25 per cent. extremely frequent, but always very clear and very distinct.

It is to be remarked that the vibrations are very easy to count with accuracy when they are not very frequent. If, then, we do not wish to allow the fire-damp to exceed a certain determinate limit that would give the formenephone say three vibrations per second, it will always be easy to remain below this limit in counting the vibrations by means of a simple seconds watch. We must also remark that it is possible for a determinate quantity of fire-damp in the air to render the vibrations of the formenephone more or less frequent, by changing the pitch of its organ pipes. The higher the pitch, the more frequent the vibrations, everything else being equal. We shall see further along a very exact method of counting these vibrations even when they are very frequent.

The principle enunciated above gives rise to two types of apparatus: (1) The portable formenephone designed to analyze in a few seconds a mixture of air and a gas not having the same density, and especially to verify the state of the fire-damp in a mine gallery. This apparatus is represented in Fig. 1 in operation in a mine. In Fig. 2 we give an explanatory section of it. The device consists simply of two bellows, A and A' (Fig. 2), and of two organ pipes, J and J'. One of the bellows, A, and its organ pipe, is inclosed in a tight metallic drum containing pure air, which is only put in circulation by the bellows in order to make the organ pipe speak, and never leaves the apparatus. The other bellows, on the contrary, takes in the mixture of air and fire-damp by means of movable tubes, L and L', at the most convenient place, even at the top of the gallery. A special arrangement permits of freeing the gaseous mixture of the dust and carbonic acid that it may contain.

Weights, P and P', bear upon the top of each bellows and are fixed thereto. These weights can be raised and the bellows be opened by means of levers, D and D'. Ratchet wheels, E and E', and their clicks, F and F', keep the bellows open. It suffices then to free the two clicks at the same time by pressing on their tail in order to make the two organ pipes speak at the same time and give vibrations, if there is any fire-damp in the gallery. (2) The fixed formenephone of continuous indications, the bellows of which are actuated by any sort of small motor (electric, water or compressed air), is capable not only of making its vibrations heard in the gallery in which it is installed, but at a distance in one or more offices. To this effect, a microphone is installed upon each of the organ pipes. The current from a battery traverses them in succession and afterward passes through an ordinary telephone receiver. Under such circumstances, if the receiver is put to the ear, we hear the pure sound of the pipes if there is no fire-damp, or the vibrations repeated with perfect clearness if there is any fire-damp in the gallery. In order to avoid putting the telephone receiver to the ear, the receiver is replaced by a microphone amplifier. This latter is formed of an electromagnet mounted upon the poles of a permanent horse shoe magnet. A vibrating steel plate is more or less attracted by this electromagnet, according as the current coming from the microphone has undergone more or less variation in intensity. The vibrating plate carries a finger, at the extremity of which is inserted a conical carbon. A very light spring, insulated electrically, carries a flat carbon that rests upon the conical one. The current from a local battery traverses these two carbons and passes through a telephone receiver of large dimensions provided with an ear piece.

Under such circumstances, the variations in intensity of the current coming from the microphone are shown by greater variations in intensity in the current of the local battery, so that the receiver provided with the ear piece repeats the same sounds as the microphone, but in amplifying them considerably—about four hundred times, and even many more in certain cases.

In order to obtain results of great precision or to preserve a trace of the quantity of fire-damp that is found at a given moment in a mine gallery, the vibrations of the formenephone are marked upon the revolving cylinder of a registering apparatus upon which is marked also the second. It is then possible to count exactly the number of vibrations per second, and to thus know with great accuracy the quantity of foreign gas mixed with the air.

Up to the present we have spoken almost exclusively of the use of the formenephone for the analysis of mixtures of air and formene, but it is equally adapted to the analysis of mixtures of air and any other gas not having the same density, and especially mixtures of air and carbonic acid. Installed in a room of ordinary dimensions, it gives vibrations due to the air vitiated by the carbonic acid of respiration, when such room has been occupied for a few hours by but one person. —*La Nature.*

OIL OF COPRAH AND PALM OIL.

AT from 30° to 31° the oil of coprah, if pure, is soluble in twice its volume of absolute alcohol. At the same temperature palm oil is soluble in four times its volume of absolute alcohol. If mixed with sparingly soluble vegetable oils or animal fats to the extent of 1-20th or less, both become almost insoluble in the same quantity of absolute alcohol, the solvent action of which does not occasion a fractioned separation of the component parts. The mixture has acquired solubility which is peculiar to it, and which does not depend on the proportions of soluble fatty matters of which it is composed.

These differences of composition enable us to determine with precision the purity of these solid oils, a chemical analysis of which often gives uncertain and even contradictory results, especially for slight admixtures.

First Process.—Shake up for one minute, in a test tube graduated in c. c., 20 c. c. of the oil under examination with 40 c. c. of alcohol at 95°. This indispensable preliminary treatment may give certain indications. Alcohol at 95° absorbs a certain quantity of the neutral fatty substances, and the oil itself dissolves from 15 to 20 per cent. of alcohol. The solvent power of the oil decreases appreciably on the addition of oils insoluble in alcohol at 95°, such as castor and resin oils—oils which may then be easily characterized by their very distinct chemical and physical properties.

Second Process.—In a test tube graduated in c. c., treat 5 c. c. of the oil of coprah (previously washed with alcohol at 95°) with 10 c. c. of absolute alcohol, and place the tube in a water bath heated very exactly from 30° to 31°. After some moments the tube is taken out, shaken very briskly for thirty seconds, and returned to the water bath. Pure coprah oil dissolves entirely, and the alcohol solution is perfectly clear.

Coprah oil mixed with insoluble oils (the commonest sophistication), arachid, sesame, cotton, maize, etc., does not dissolve appreciably, and forms a turbid mass with the absolute alcohol, from which it quickly falls in fine drops to the bottom of the tube, where it collects. Oil of coprah containing palm oil is precipitated when the proportion of the mixture reaches 20 per cent. Below that mixture the liquid remains turbid.

The verification of palm oil is effected in the same manner, using 20 c. c. of absolute alcohol instead of 10 c. c., and operating always upon 5 c. c. of oil at the temperature of 30° to 31°.

Five c. c. of palm oil containing 20 c. c. of coprah or upward dissolves in 15 c. c. of absolute alcohol; in the same proportions the pure oil does not completely dissolve, and the mixture remains turbid. The purity of coprah and palm oil cakes is found by extracting a sufficient quantity of oil by means of any solvent and treating in the same manner.—*Comptes Rendus.*

BORON BRONZE.

By H. N. WARREN, Research Analyst.

THIS alloy, or more correctly speaking, aluminum-boron bronze, is brought about by the introduction of aluminum containing boron, not as aluminum boride, but existing as graphite does in cast iron. Commercially, this part of the process is accomplished by heating in a specially constructed oxyhydrogen furnace an admixture of fluorspar and vitrified boric anhydride, until the dense fumes of boron fluoride commence to appear. At this stage, ingots of aluminum are introduced into the liquid mass; reduction at once takes place, with the formation of free boron, which dissolves in the aluminum, rendering it crystalline and somewhat brittle. When this so prepared aluminum is alloyed with copper to the extent of from 5 to 10 per cent., a bronze is obtained, denser and more durable than ordinary aluminum bronze, and free from brittleness; but the most peculiar property is the perfectness with which it casts and melts; whereas, in the manufacture of aluminum bronze, one of the greatest difficulties is to insure a uniform mixture. Often a very difficultly fusible alloy of copper and aluminum is formed upon the surface of the already melted portion, and accompanied by superficial oxidation, thus obstinately refusing to alloy with the remainder. But in the case of the boron compound no such difficulties are met with, the alloy melting perfectly, and at lower temperature than when employing pure aluminum. Boron, in fact, seems to have been little studied, but it is evidently not so serious an enemy to cope with as its halogen silicon, which, when present in minute percentages only, determines the total ruin of the bronze with which it alloys; in other words, it stands almost entirely opposite to other elements, entering into the formation, and forming compounds with the more

refractory metals with the greatest ease; for instance, borides of iron, manganese, nickel, cobalt, etc., may be readily formed by the reduction of their accompanying borates in the presence of carbon, while those of silver, copper, gold, etc., can only be formed by the introduction of elementary boron into the fused mass; borides of the alkali metals, and even calcium, barium, etc., have also been obtained, but boride of mercury still holds out.—*Chem. News.*

[Continued from SUPPLEMENT, No. 944, page 15091.]

ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

Lecture III.†

IN the last course of Cantor lectures on "Alloys," I described the experiments which led me to the view that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect. The results attracted much attention, and the Institution of Mechanical Engineers appointed a strong committee in order to ascertain whether the action of impurities on masses of metal is in accordance with the periodic law of Mendeleeff. Two reports have already been presented by this committee, from which it appears that while the law does apply to iron, it is only partially true in the case of copper.‡

A fact of considerable industrial importance was established in connection with the use of copper for fire boxes for steam boilers, as it was shown that the presence of a small quantity of arsenic is positively beneficial, and not harmful, as it has hitherto been supposed to be.

Many points of interest in connection with the constitution of alloys were developed in the course of these reports, and one relating to the effect of pressure on the molecular change in fusible metal may be mentioned here.

It has long been known§ that when a triple alloy of bismuth, lead, and tin, which bears Newton's name, is cooled down from the molten state, there occurs, long after the metallic mass has solidified, a remarkable rise in its temperature. Experiments made in view of the report show conclusively that this evolution of heat occurs generally at 46° C. An evolution of heat also takes place if the solid mass is cooled rapidly by quenching in water. This effect, however, disappears after the third or fourth heating, but may be restored by remelting the mass, or by raising it to a temperature just below its melting point. A suitable alloy for the experiment is the one containing 50 per cent. bismuth, 31¼ per cent. lead, and 18¾ per cent. tin. The appearance of the fractured surface of the mass, if broken before the evolution of heat, is plate-like, crystalline, and almost vitreous; but after the thermal change the fracture is gray, dull, and finely grained. It will be evident that the changes this alloy undergoes present certain analogies to those which take place in steel during the "hardening" by rapid cooling from a high temperature, and when the metal cools slowly from bright redness. In the latter case, if low carbon steel be the subject of the experiment, there are at least two distinct evolutions of heat, one at 855° C., due, it is believed, to a molecular change in the iron, and the other at 655° C., arising from a change in the relation between the carbon and the iron. Newton's alloy, now under consideration, contains three constituents; and the alteration which is made evident by evolution of heat must clearly be due either to a change in the mutual relations of the constituent metals or else to polymerization or redistribution of the atoms in the molecules of the solid mass, either of which changes is attended with the evolution of heat. That molecular modification does take place in these alloys during cooling has been shown by E. Wiedemann‖ and by Spring.¶ In steel, carbon is present, and complicates the problem under examination, which is not the case with Newton's alloy; but in the latter it is possible that one or other of its three constituent metals may play a part analogous to that of carbon.

A careful study was therefore made of the behavior of the alloy, and it may be well to publish the results in full at some future time; at present it is only necessary to summarize the conclusions to which the investigation appears to lead. The question arises, Is the quenched Newton's metal the analogue of hardened steel? First, as regards change of volume; Ermann, and afterward Kopp, found that the expansion of similar alloys is abnormal. The present experiments show that the change from the vitreous variety of the alloy to the finely crystalline one is accompanied by an expansion in its volume of about 0·8 per cent. Steel also expands during the operation of hardening. The tenacity of the alloy in the vitreous state is very low, only about 1 ton per square inch; but after the molecular change a maximum of 2¼ tons per square inch is attained, the effect being the same whether the change has taken place spontaneously or has been induced by rapidly cooling the alloy. Annealing the bars at a temperature of 80° to 90° C., after the molecular change has taken place, appears slightly to increase their strength. The alloy solidifies at or about the temperature of 96° C., with a range of pastiness extending over several degrees, which prevents any mechanical measurements from being made until the mass has cooled to about 93° C. Throughout the range of temperature between 92° and 80° C. it contracts at an average rate of 0·000144 of its length per degree Centigrade; and the contraction continues, but in gradually decreasing amount, until at 49° C. it ceases, and the metal commences to expand. The amount of the expansion is considerable, nearly one per cent. of its linear dimensions, and appears to be due to some process resembling that of combination, for it requires an appreciable amount of time for its complete development, and is accompanied by a considerable evolution of heat. If, on the other hand, the alloy be cooled too slowly, the evolution of heat is not well marked. The converse phenomena of contraction with absorption of heat, noticed upon reheating the alloy, does not occur at the expected temperature, but at a higher one; and the fact that the change is not truly reversible supports the view that the molecular change in the alloy is due, as is doubtless the case in steel, to combination on cooling and to dissociation on heating occurring in the solid mass.

Under these circumstances it became interesting to see whether the application of pressure would cause the change to take place at a lower temperature than that at which it would occur without pressure. A steel die was formed with a surrounding water-jacket (Fig. 4). The plug of the die had a steel socket, in which

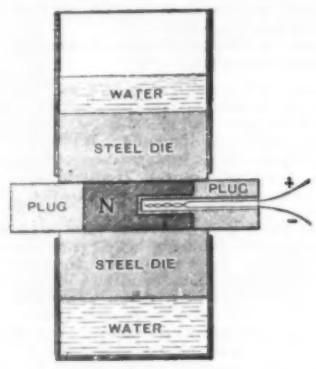


FIG. 4

the thermo-junction was inserted, so that the pressure did not come upon it in any way. This was found to be necessary, as otherwise the insulation failed, and the metal was "squirted" along the wires, causing a short circuit. The alloy, N, was poured into the cavity of the die, which had previously been lined with several folds of paper; the die was closed and placed in the press, and then heated until the metal again became fluid. A steady stream of cold water was then run through the water-jacket, and, by the thermo-junction, inserted in the socket before mentioned, an autographic record of the temperature was taken, while pressure was steadily applied to the die. It had previously been found that the abnormal rise in temperature in the absence of pressure was coincident with the expansion of mass. The result of the experiment showed that, under a pressure of one ton per square inch, the temperature at which the thermal change took place was lowered as much as 4° C., and that a pressure of about four tons per square inch was sufficient to obliterate the thermal disturbance altogether. It is interesting, therefore, to see that, where the pressure is sufficient to cause the particles of the mass to assume the quasi-fluid state, the changes are greatly modified.

The effect of pressure in lowering the critical point in this alloy is evident; and it was interesting thus to ascertain whether the compression of the mass had really prevented the alloy from undergoing the molecular change from the vitreous to the gray variety, or whether the "recalescence" had been so gradual that there was no sudden augmentation of temperature in the cooling mass, such as would be indicated by a marked discontinuity in the autographic curve. The die was accordingly made in halves, so that it could be rapidly opened when the pressure was released. The solid cylinder of compressed alloy was removed and fractured with as little delay as possible; but it was found that the change, though not complete, was far advanced. It is impossible to say whether the change occurs directly the pressure is removed or during the time it has been applied.

The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by Professors Dewar and Fleming.* The diagrams, Figs. 5 and 6, will serve to make

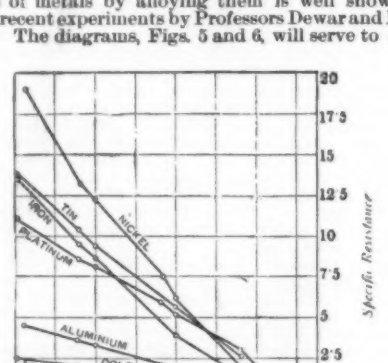


FIG. 5.

clear the nature of their remarkable results. They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys; and the results tend to prove that, if pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft, pliable metals like gold and rigid ones, such as nickel. Impure metals and alloys behave very differently; the diminution of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

Mr. Laurie has continued his researches by which he determined the electromotive force of alloys, with a view to obtaining indications as to their molecular grouping. His work on the tin-copper series was referred to in the last course. He now shows that if the method he previously adopted be applied to the alloys formed from zinc, tin, lead, and cadmium, which are grouped together by Matthiessen as forming mixtures only with each other, the electromotive force rises at once on introducing only a small quantity (about 1 per cent.) of the more pristine metal, thus confirming Matthiessen's view. The method has also been applied to the tin-gold alloys with the following results. Matthiessen found, on plotting the conductivities of these alloys, that the resulting curve resembled a W, having one maximum point and two minimum. He

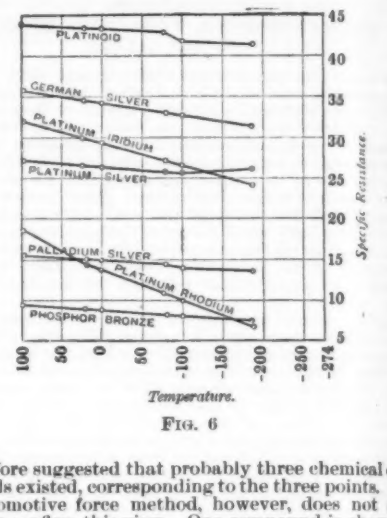


FIG. 6

therefore suggested that probably three chemical compounds existed, corresponding to the three points. The electromotive force method, however, does not altogether confirm this view. One compound is shown to exist corresponding exactly with the maximum point of the curve. Mr. Laurie has suggested that probably this result gives the correct interpretation of Matthiessen's curve, and that only one compound exists. The compound may, from its behavior, be regarded as if it were the dip of the curve on each side corresponding to the curves obtained by Matthiessen for other metals where no compound exists, but where a small trace of one metal profoundly alters the properties of the other metals with which it is mixed.

The analogy of alloys to natural silicates has been pointed out by Mr. H. M. Howe, who also shows that the action of impurities on alloys resembles that of foreign matter in silicates; for, as he says, the presence of one or two per cent. of soda would at once alter the fusibility of any silicate.

Mendeleeff* also shows that the crystallization of igneous rocks is similar to the behavior of certain metals forming a homogeneous alloy from which definite crystalline compounds separate as the mass cools. As evidence that certain alloys have a constitution which resembles salts, he says that an alloy of sodium and zinc is, in a wide sense, a salt in many of its reactions, for it is subject to the same double decompositions as sodium phosphide or sulphide, which clearly have saline properties. The latter when heated with ethyl-iodide forms ethyl-phosphide, and the alloy of zinc and sodium gives zinc ethyl; that is, the element (P, S, Zn) which was united with the sodium passes into combination with the ethyl

$$RNa + Et\,I = REt + Na\,I;$$

hence, the alloy of zinc and sodium is a saline substance in the same sense that sodium sulphide is.

The following circumstances may also be observed: With chlorine, sodium gives one compound; with oxygen, at the most three; with sulphur, five; with phosphorus, probably still more; with antimony, naturally, still more; the more analogous an element is to sodium, the more varied are the proportions in which it is able to combine with it, the less are the alterations in the properties which take place by this combination, and the nearer does the compound formed approach to the class of compounds known as indefinite chemical compounds. In this sense, a silicious alloy, containing silica and other acids, is a salt. The oxide, to a certain extent, plays the same part as the soda, while the silica plays the part of the acid element which was taken successively by zinc, phosphorus, sulphur, etc., in the above examples.

Such a comparison of the silica compounds with alloys presents the great advantage of including under one category the definite and indefinite silica compounds which are so analogous in composition: that is, it brings under one head such crystalline substances as certain minerals, and such amorphous substances as are frequently met with in nature, and used artificially prepared, as glass, slags, enamel, etc.

If the compounds of silica are substances like the metallic alloys, then (1) the chemical union between the oxides of which they are composed must be a feeble one, as it is in all compounds formed between analogous substances. In reality, such feeble agencies as water and carbonic acid are able, although slowly, to act on and destroy the majority of the complex silica compounds in rocks. (2) Their formation, like that of alloys, should not be accompanied by a considerable alteration of volume, and this is actually the case.

Dr. Alder Wright's† experiments on the distribution of a constituent of an alloy between two other constituents considered as solvents must be consulted in his original papers, which are too elaborate for useful abstraction here.

The same must be said of Colonel Edward Matthey's‡ very interesting and important papers on the "liquation" of alloys of precious metals. Working with masses of metal worth thousands of pounds, he has done more than any recent experimenter to clear up

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* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† This lecture was an experimental one, and is here given in a somewhat abbreviated form.

‡ "Proc. Inst. Mech. Engineers," 1891, p. 543; and 1893, p. 102.

§ Dittie, "Lecons sur les Metaux," 1891, part i., p. 21.

‖ Wiedemann's "Annalen," vol. iii., 1878, p. 237.

¶ "Bulletin de l'Academie Royale de Belgique," vol. ii., 1886.

* "Phil. Mag.," vol. xxxiv., 1892, p. 327; vol. xxxvi., 1893, p. 271.

* "Principles of Chemistry," vol. ii., p. 113, note 21.

† "Proc. Roy. Soc.," 1889-93.

‡ "Phil. Trans.," vol. lxxxiii., 1892, p. 629.

this curious molecular behavior of alloys, which is of so much industrial importance.

There can be no question that the general interest in alloys deepens daily, and one very gratifying indication of this fact is afforded by the notes on alloys which have from time to time been published in recent volumes of *Industries*. The appearance of these notes, which deal more particularly with alloys of industrial importance, renders it the less necessary to do more, in the brief space of these lectures, than pass in review those particular portions of research connected with alloys which appear to afford the most hope of immediate progress.

[Continued from SUPPLEMENT 944, page 15090.]

STUDIES OF THE PHENOMENA OF SIMULTANEOUS CONTRAST COLOR; AND ON A PHOTOMETER FOR MEASURING THE INTENSITIES OF LIGHTS OF DIFFERENT COLORS.*

By ALFRED M. MAYER.

A photometer for measuring the intensities of differently colored lights.—It has already been shown that, in certain conditions of illumination and in certain directions of sight, a screen formed of perforated cardboard covered with translucent paper appears with complementary colors, and that if the screen be in the form of a disk with alternate sectors cut out of it, and is illuminated on one side by daylight and on the other side by lamplight, the blue of one side of the disk and the orange of the other appear intensified on slowly rotating the disk. On increasing the velocity of rotation the complementary colors gradually blend, and when the velocity of rotation has banished all flickering light from the disk it appears nearly white. The side facing the daylight has a slight yellowish tint; the side facing the lamp appears whiter, but is tinted with a feeble bluish hue.

To study more minutely these phenomena I made a disk which could be readily taken apart and mounted with different translucent papers, and have attached to it disks and rings of various colors. I shall call this disk *the photometer disk*. It is made as follows:

Two disks, 13 cm. in diameter, and having eight sectors cut out, as shown in Fig. 13, were made of thin

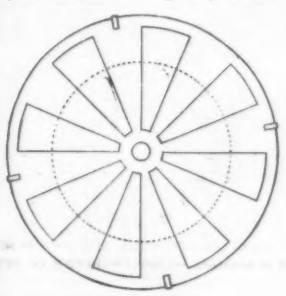


FIG. 13.

Bristol board. A circle of 2 cm. in diameter was left in the center of the disk, from which the cardboard sectors radiate. The border of the disk is a ring of ¼ cm. wide, which was painted black. Clamps made of thin hammered brass held these disks together.

Between these disks was placed a circle of the same white translucent paper used in the construction of the large contrast color screen, Fig. 1, and the disks were clamped together with the open sectors of the two disks coinciding in position. A black disk of 8·2 cm. in diameter was placed on each side of the photometer disk, thus leaving between it and the black peripheral ring an annular space of 1·9 cm. wide, formed of alternate spaces of cardboard and of translucent paper. The disk was mounted on a rotator and placed opposite two silvered mirrors inclined at an angle of 150°; an arrangement similar to that of Letheby for observing the disk of Bunsen's photometer. The plane of the disk of the rotator bisected the angle formed by the mirrors, as shown in Fig. 14,

FIG. 14.

so that the surfaces of both sides of the disk could be seen simultaneously, or, rather, in rapid succession. On rotating the disk while illuminated by daylight on one side and by lamplight on the other, the side illuminated by daylight appeared white tinted with yellow; the side facing the lamp appeared white tinted with blue. The hues were the same as described in the experiment with the large disk, Fig. 8, only the surfaces appeared brighter by contrast with the black center and border.

The feeble character of the hues on the photometer disk led me to hope that I could bring these to the same hue on both sides of the disk by the effects of contrast. To accomplish this I placed on the daylight side of the photometer disk a compound disk formed of three split disks, one of red lead, one of chrome yellow, the other of white Bristol board. On the lamplight side I placed a disk formed of three split disks, colored ultramarine, emerald green, and one of white Bristol board. On rotation, the compound disk on the daylight side gave an orange yellow; on the lamplight side the disk gave a bluish green. These colors corresponded in hue to those seen on the respective sides of the ring of the photometer disk when it is rotated, only the hues were much more saturated. After a few trials I brought, by the contrast effects of these colored disks, the tints on the two sides of the ring of the photometer to the same hue; the translucent ring appearing white, with a very slight orange yellow tint on both of its sides. The greenish blue had by contrast effect obliterated the blue tint of the ring and even replaced it by a very feeble orange yellow; while on the other side of the ring the orange yellow disk had diminished the orange yellow tint of the ring to the same feeble orange yellow as seen on the other side of the ring.

Experiments were now made to test this apparatus as a photometer. Equality of illumination cannot be determined with any precision if the two surfaces compared differ even slightly in hue. Here we had the hue to deal with on both sides of the ring; which condition is different from the Bunsen photometer, on which we have two colors on each side of the disk. Various methods were tried to render reliable the comparison of the illumination of the two sides.

(1) I used the eye alone, regarding only the portions of the ring on the border near the mirror, shown in Fig. 14.

(2) Two prisms reflected the images of portions of the sides of the ring nearest the mirror to juxtaposition, as shown in Fig. 15.

FIG. 15.

(3) A tube blackened on the inside, with a black screen on the end next the disk, as shown in Fig. 16, was used. The eye was thus shielded from extraneous light and the comparisons of illuminations were made, as in experiments 1 and 2, on the portions of the rings which were nearest the mirror as shown in Fig. 16. Vision through this screened tube gave the best results.

After practice in such comparisons, made during

FIG. 16.

several hours on different days, I became more and more skillful and the results of measurements become more concordant; but such methods of photometry do not approach the accuracy of those in which two contiguous surfaces of different degrees of translucency coalesce into one surface of a uniform illumination, as happens on the balance of illuminations on the two sides of a Bunsen photometer disk when these are illuminated by lights of the same intensity and of exactly the same hue. A photometer for this mode of observation is described in the following section. It has, however, the advantage over the Bunsen photometer in that it serves to measure the intensities of differently colored lights.

The rotating disk photometer.—The photometer disk was taken apart and a ring of thin white linen paper* of the diameter of the disk and 9·10 cm. wide was laid on one of the disks; this was covered by the circle of thin translucent white paper and on this was laid another ring of the thin linen paper. The other sectored disk of cardboard was placed on these and the disks were now clamped together. The outer portions of the open sectors of the disk were thus closed by two thicknesses of the thin linen paper with the "alba tracing paper" between them, *a*, in Fig. 17; while the inner portions of the sectors were closed by the tracing paper alone, *b*, in Fig. 17.

On rotating the disk, it was not possible to balance the colors of the outer half (*a* in Fig. 17) of the ring

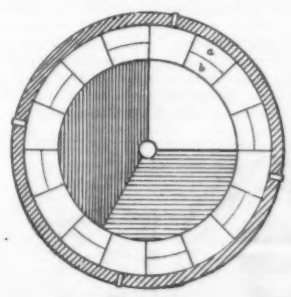


FIG. 17.

formed of three thicknesses of paper, with the same central colored disks used in the previous experiment, when one side of the disk was illuminated by lamplight, the other by daylight. But on increasing the saturation of the hues of the central disks and adding peripheral rings of the same hues, I succeeded in making the hues the same on both sides of the photometer ring. If equality of hue can be obtained when the photometer is illuminated on one side by lamplight and on the other by daylight, then the contrast colors may be brought to the same hue when the photometer is illuminated on one side by a candle or petroleum flame and the other side by the electric arc light or by the whitest Welsbach incandescent lamp.

With a change of distance of the petroleum flame from the photometer the differences in the illumination of the portions, *a* and *b*, Fig. 17, of the ring were changed. When the two sides of the ring were equally illuminated the rings, *a* and *b*, appeared indistinguishable, fusing into one ring of uniform tint and illumination, of the breadth of $a + b$.

With the best Bunsen photometer disk* I was unable to decide where it received equal illumination on its sides, so difficult was it to judge of equal brightness of the blue and orange on one side when compared with the orange and blue in the same respective positions on the other side of the disk.

With a petroleum flame of 40 candle light giving power on one side of the rotating photometer and a candle on the other, the delicacy of the indications of the rotating photometer equaled, and even slightly excelled, those of the very best Bunsen photometer disk.

If we bring in succession the translucent sectors of the rotating photometer disk between two lights, we observe that, on certain sectors, *a* and *b* appear as one surface of the same uniform tint and illumination; on other sectors sometimes *a*, sometimes *b*, is the brighter. Rotation of the disk entirely destroys such slight differences, and the disk then acts as if made of absolutely homogeneous material, placed in the same conditions of contact of the layers of paper, in each translucent sector.

The hue of the light of "a white incandescent Welsbach lamp" compared with daylight.—When the screen, Fig. 1, is illuminated on one side by the Welsbach lamp and on the other by daylight, the side of the ring of the screen facing the daylight appears a feeble blue decidedly tinged with violet. The side of the ring facing the Welsbach lamp is colored greenish orange. This greenish orange was matched in hue, but not in luminosity, by a rotating disk having 41·5 parts of red lead, 41·5 of chrome yellow and 17 of emerald green, viewed illuminated by daylight. This appears to be the hue of the Welsbach light when compared with daylight.

Experiments in which are compared the hues of the light of an incandescent Welsbach lamp and of candle light.—When "a white light incandescent Welsbach lamp" is placed on one side of the large screen, Fig. 1, and a candle, or petroleum flame, on the other side, the cardboard ring of the screen facing the Welsbach light appears of a light bluish green; the side of the ring facing the candle, or petroleum flame, appears of a light carmine.

Matching these hues on the rotator with split disks gave the following results when the two sides of the screen were equally illuminated. The hue of the ring on the side facing the Welsbach lamp was matched by 8 parts of emerald green, 10 of cobalt blue, 25 of ivory black, and 57 parts of white Bristol board, as seen illuminated by the Welsbach lamp. The hue on the side of the ring facing the candle or petroleum flame was matched by 12 of carmine, 17 of ivory black and 71 of white cardboard, as seen illuminated by the petroleum flame.

Experiments with the rotating photometer disk placed between the Welsbach lamp and the petroleum flame.—On rotating the photometer disk, without any central disks, between these lights, the same hues as those already described were seen on its sides, only these hues were much less saturated.

The white disks placed on the sides of the rotating photometer made the hues less saturated.

With a white disk on the petroleum flame side and a black disk on the Welsbach lamp side, the difference between the hues of the sides of the photometer was more pronounced.

With a disk of cobalt blue, emerald green and white on the Welsbach light side and a white disk on the petroleum flame side, the side of the photometer facing the Welsbach lamp appeared white and the side facing the petroleum flame was less carmine; the differences in hue being less than in any of the previous experiments.

By trial I found that when a disk of 33 parts of emerald green, 42 of cobalt blue and 25 of white was placed on the Welsbach lamp side of the photometer disk, with a ring of the same hue on the periphery and a disk of 75 parts of carmine and 25 of white was on the petroleum flame side of the photometer disk, with a ring of the same hue on the periphery of the photometer, the sides of the photometric ring of the photometer had the same hue; which was white tinged with just a perceptible carmine.

We are now in condition to make an interesting experiment which shows in a striking manner the effects of the colored central disks and peripheral rings on the colors of the photometric ring of the photometer. The exact balance of hue on both sides of the photometer has been obtained. Reverse the photometer disk with its central disks and rings and rotate the disk in front of the mirrors. We now see the photometric ring with strong contrast of color on its sides, and the concentric rings, *a* and *b*, are separately seen, not appearing indistinguishable, as in the previous experiment. By the reversal we have, by the effects of the colored disks and rings, added to the effects produced alone by the lights.

It is to be noted that the colors on the disks and rings of the photometer must not be too saturated in hue. The elementary disks of these compound color disks should be made of thin Bristol board, and after they have been painted should be well flattened before they are slit radially. After the proper hues have been obtained for the disks which correct the color of the photometric ring the same hues should be painted on single disks, which are subsequently flattened. The thinner the color-correcting disks and the closer they fit to the photometer disk, the greater is their contrast color effect. The colored rings must be cut out of the painted cardboard, for if the rings are painted after they are formed, it is very difficult to make them flat.

To render easy the making of this photometer I made experiments so that one could get the proper hues of the correcting disks and rings by mixtures of

* From the *American Journal of Science*, vol. xlvi., July, 1893.

* The best paper I have experimented with for this purpose is watermarked "Crane & Co., Dalton, Mass., Bond, No. 21."

* The best Bunsen photometer disks I have used are those sold by the American Meter Company, of New York. They are made in England.

definite weights of the pigment powders and definite volumes of gum water; but it is less troublesome to paint a few disks with colors variously saturated and repeat the experiments I have described, and thus furnish one's self with the sets of disks and rings necessary for the photometric measures of the arc electric light, of the Welsbach white burner, etc., when compared with the standard candle or petroleum flame.

The rotator on which the photometer disk is revolved should be made as shown in Fig. 18, so that the

FIG. 18.

standard, S, and the pulley, P, which is driven by the wheel, W, shade as little as possible the rotating disk, D.

Photometric measures with the rotating disk photometer.—On one side of the photometer was placed "a white Welsbach burner" with a light-giving power of 33 candles, on the other side a standard candle. As the candle was gradually brought nearer the rotating photometer the illumination and hues of the portions, *a* and *b* (Fig. 17), of the photometric ring approached equality, and when the candle was at a certain distance the difference of illumination and hues of *a* and *b* become indistinguishable, and only a band with a breadth of $a + b$, with a uniform surface, was observed on the sides of the photometric ring.

The measures of the intensity of the light of the Welsbach lamp in terms of the standard candle were made by a friend. He made sixteen measures with my rotating disk photometer and sixteen with the Bunsen photometer.

The mean of the series of measures made with the rotating disk photometer differed from the mean of the departure of the maximum and minimum measures from the mean by 1·49 per cent. of the mean intensity of the light of the Welsbach lamp.

The mean of the series of measures made with the Bunsen photometer differed from the mean of the departure of the maximum and minimum measures from the mean by 5·22 per cent. of the mean intensity of the light of the Welsbach lamp.

THE TALKING WATCH.

THE prestidigitator asks of the spectators the loan of a watch and chain. Having obtained it, he holds

FIG. 1.—PRESTIDIGITATOR SHOWING THE TALKING WATCH.

the watch by its chain with the right hand, and it begins to strike.

"I beg your pardon, sir," says he to the owner, "I asked you to entrust me with a watch, but I should have preferred that it had not been a repeater."

"But my watch is not a repeater," says the owner.

"Indeed, it is, sir," says the prestidigitator, "and I am going to profit by it in questioning it. How do you say yes (the watch strikes); and say no (the watch remains silent). Very well, with yes and no we can converse at our ease. Are you very fond of your owner? (the watch is silent). Would you rather remain with me? (the watch strikes). Henceforward, then, you will remain with me (great clatter of bells). See how glad it is. In order to appreciate your qualities, I am going to ask you a few questions."

"Be kind enough, sir," says the prestidigitator to the owner, "to give us two different figures, and the

FIG. 2.—APPARATUS FOR PRODUCING THE SOUND.

watch will give us the total of them (the watch strikes the added figures)."

The prestidigitator lays the watch upon a round table, takes a pack of cards and asks the spectator to select one (of course, it is a forced card known in advance by the operator).

"Is it a heart?" (the watch is silent).

"Is it a spade?" (the watch strikes).

"Is it a face card?" (the watch is silent).

"Then it is a small card" (the watch strikes furiously).

"It is useless to try to control you, strike as many times as there are spots" (the watch strikes eight times).

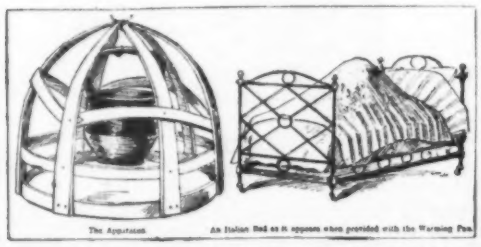
"But here is something better: Tell me who is the most untruthful person present. Is it a lady?" (silence). "Is it a gentleman?" (watch strikes). "A gentleman among the spectators?" (silence). "Could it be me?" (furious striking of the watch). "Take your watch, sir, I have no further use for it."

Explanation.—This illusion is due to a little apparatus concealed in the vest pocket. It consists of a small copper box of the diameter of a five franc piece and about three centimeters in thickness. This box contains a small gong in which is placed a clockwork movement that actuates the hammer. This movement, wound up in advance, is capable of sounding about twenty-four times. It is provided with a stop button placed upon the exterior of the box. Upon pressing this button the gong sounds, but ceases to do so when the pressure is removed. This button may be actuated by hand, and it is here that the process employed becomes truly curious: The apparatus being placed in the vest pocket, it suffices to compress the abdomen or distend it in order to have the button, compressed or set free, cause the apparatus to sound or remain mute.—*Le Magasin Pittoresque.*

ITALIAN METHOD TO KEEP WARM.

IN these days of travel it is hardly necessary to say that the cold of an Italian winter is of a peculiarly searching and trying kind. Until lately charcoal and wood have been the only materials available for cooking and warmth, and English visitors and residents have always grumbled loudly at the discomfort of Italian houses and apartments. Now, however, a great find has been made of two apparently inexhaustible sources of fuel, and possibly later on of gas. About a year ago the Marquis de Genori discovered that his immense estate round the Lake of Massaciuccoli, near Viareggio, was rich in peat, the very existence of which in Tuscany had long been disputed by geologists and experts. No time was lost in turning the discovery to good account; the requisite machinery for production was constructed, and although hand labor only was at first employed, peat (*torba*) in the convenient form of solid blocks of convenient size was for sale last year in Florence and elsewhere at a very low price. It is now becoming popular in Tuscany, and is much sought after, so that if, as is stated in the *Nazione*, the enormous valley of the Maremma and the Pontine Marshes are equally productive, a new industry on a vast scale will shortly be created. It is further stated that gas can be produced from *torba* of so chemically pure a quality as to reduce to a minimum the cost of cleansing gasometers.

The other combustible material which has also been recently "unearthed" is called *lignite*, and is thus described in the dictionary of the *Crusca* Academy: "Wood which having been buried by a convulsion of nature has become carbonized, but without losing its vegetable characteristics." Lignite is in appearance very like slaty coal, and is of considerable weight. It burnt slowly, with little smoke, gives great heat and has no smell. It is found at S. Giovanni, Val d'Arno, Tuscany, and also in the Maremma, and the supply of



HOW TO KEEP WARM IN BED—THE ITALIAN EDITION OF THE WARMING PAN.

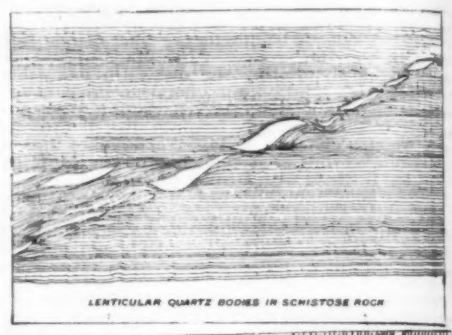
it seems to be unlimited. The mountains around the former place, indeed, appear to be in part built up of it. The manner of extracting it is simple in the extreme. The mountain is tunneled to a certain distance, rails are laid down, and wagons filled with great ease and rapidity. The price of *lignite* is slightly in excess of that of *torba*, but both are infinitely cheaper than any other class of fuel hitherto produced.

Whatever facilities, however, the Italians may have in the future for keeping themselves warm, it is quite certain their old methods will long survive. No Italian apartment, however humble, is without its *cassette* for the feet. They are oval boxes, generally of brass, with perforated lids, and are filled with *brace*, or small burning charcoal. *Scaldini*, heated in a similar way for warming the hands, are terra cotta baskets of graceful shape, with a circular handle by which they can be carried about; but the quaintest of all appliances is the Italian substitute for the warming pan. It is simply a wooden cage open at the bottom, inside which is swung by a strong wire the earthenware *scaldino*, full of live charcoal. This apparatus is introduced under the bed clothes, and a bed so charged presents at first sight, as will be seen from the sketch, a most startling appearance.—*Daily Graphic.*

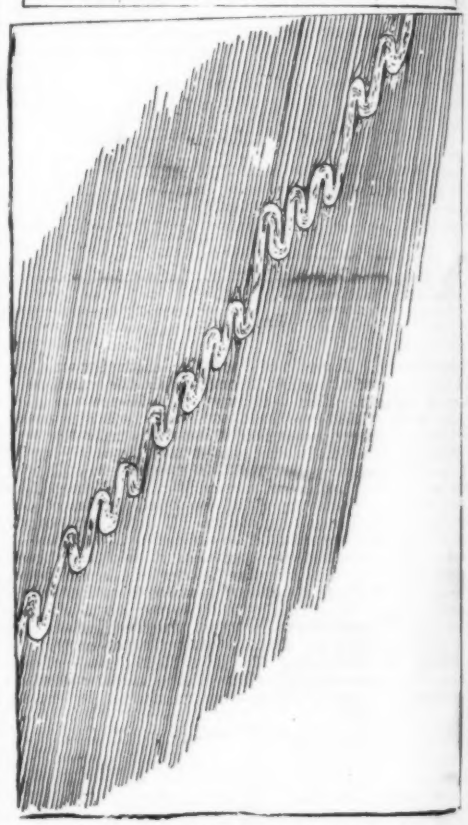
CURIOUS MINERAL FORMATIONS.*

THE Helvetia, like other mines near Julian, San Diego County, occurs in the crystalline schists, the quartz being found as lenses inclosed in the country rock. Some of the lenses might be mistaken for fissures, but I failed to see one possessing the characteristics of a "fissure."

Nearly all the lenses exhibit a tendency to "make" into the hanging wall side of the country rock, the



LENTICULAR QUARTZ BODIES IN SCHISTOSE ROCK



CURIOUS MINERAL FORMATION.

lenses of quartz following each other in a general direction, but at an angle with the stratification of the schists, and are separate and distinct from each other, being separated at the ends (where they sometimes overlap) by the "leaves," as they may be termed, of the schistose country rock. These lenses were doubtless caused by a compressive stress on the schists, which had a tendency to split them, but was not powerful enough to cause an abrupt fracture. The accompanying sketch may convey an idea of the occurrence of these quartz lenses.

By the accompanying sketch it will be observed that there is a tendency on the part of the quartz lenses to follow a given direction, which lies at a small angle across the strike of the schists, and that these lenses are not connected, but occur independently, though all are the result of the same force which flexed and split the strata.

The Ready Relief, near Banner, has several levels, all of which are connected by winzes and shafts. The huge bunches of quartz have, from their peculiar form, been denominated "rolls," and I know of no better term which would convey a clear idea of their appearance. As a result of close observation made at numerous points in the mine and on the surface at the time of my visit, I formed the conclusion that the "rolls" of the Ready Relief mine simply represent an exaggerated condition of the same sort of flexing of the schists that has produced the other mines of this dis-

* Extract from report of W. H. Storms, Assistant in the Field, in Eleventh Report of State Mineralogist.

trict. The facts as observed lead me to the belief that the "rolls" or folds of the Ready Relief mine, and its extensions, both north and south, are the result of a severe compressive stress upon the schists at right angle to a line running nearly northwest and southeast; that this force was exerted in the form of pressure and not of contraction; that as a result of this pressure there is a tendency exhibited on the part of the contorted strata to form a reverse fault and not a normal one, and that this power expended itself before the rocks were forced to yield to the strain to the extent of fracture, the result being an abrupt crumpling of the schists without disruption.

Along this line of disturbance percolating waters have deposited silica in enormous quantities. The schistose folded masses have been completely metamorphosed, massive quartz replacing the crushed and crumpled crystalline rocks, though the lines of its former schistose structure are in many places preserved.

A sketch of a characteristic section is here reproduced, and it may help the reader to form some conception of this unusual occurrence of gold-bearing quartz. The strike of the country rock is about northwest and southeast, and varies but little from this over a wide area. The rock is, generally speaking, a dark gray, rather close grained, micaceous rock (argillite), having a dip to the east of about 80 degrees. The succession of folds cut across the dip of the schists at an angle of about 45 degrees from the horizon.

It will be noticed that in places several of the rolls lie side by side. Where this occurs the pay shoot is very large. The thickness of the individual rolls varies from a few inches to 5 or 6 feet, and where the folds parallel each other a width of 12 to 20 feet or more is not uncommon. These rolls do not extend longitudinally a great distance, but seem to gradually diminish, being followed by others along the strike of the vein. It seems quite evident that had the stress which produced this folding or crumpling of the schists proceeded much farther an abrupt fracture must have resulted, and the Ready Relief vein would have been a fissure having a dip of about 45 degrees.

FIGS. 26 AND 27.—Shoes of the Sixteenth Century. FIG. 28.—French Shoe of the same epoch. FIGS. 29 AND 30.—Neapolitan Shoe Supports. FIGS. 31 TO 33.—Military Boot of the Thirty Years War. FIG. 34.—Louis XIV. Shoe. FIG. 35.—Shoe with Lace Bow. FIG. 36.—Buckle Shoe. FIG. 37.—Embroidered Venetian Slipper. FIG. 38.—Boot of the Revolution. FIG. 39.—Shoe of the Peasant of the Abruzzos. FIG. 40.—Shoe of Russian Peasant. FIG. 41.—Spanish Gaiter. FIGS. 42 AND 43.—Turkish and Persian Shoes. FIG. 44.—Shoe of an Indian Prince. FIG. 45.—Hindoo Sandal. FIG. 46.—Anklet of Young Hindoo Woman. FIG. 47.—Japanese Sandal. FIG. 48.—Chinese Shoe. FIG. 49.—Chinese Shoe (man's). FIG. 50.—Aztec Shoe. FIG. 51.—French Sabot.

THE HISTORY OF FOOTGEAR.*

AT the beginning of the sixteenth century footgear became completely transformed. From pointed it became as wide as the hand. It no longer covered anything but the toes, and was provided with a small counter for the heel.

Such foot coverings, which bore the significant names of "goose bill" and "bear's foot," formed part of the armor of the knight (Figs. 26 and 27). On the contrary, the soldier, not much preoccupied with the protection of the foot, wore slashed shoes, which, moreover, were in keeping with his costume (Fig. 28).

In the second half of the sixteenth century, the Spanish costume, then the fashion, included anew a pointed shoe that covered the entire foot. It was accompanied with knit silk stockings, a great novelty at this epoch. Northern and Central Italy followed their own inspirations, but Southern Italy, under subjection to Spain, naturally adopted the fashions of its conquerors. Thus, at Naples, there were used shoe supports that were so high that they condemned the ladies to a difficult and uncertain mode of locomotion (Figs. 29 and 30).

It was during the thirty years war that the high footwear or boot (Fig. 31) came into fashion. It was worn by civilians and the military. The ecclesiastics, the commonalty and the peasants alone wore the low shoe. The spurs were fastened above the heel by means of straps that were concealed by a wide piece of leather (Fig. 32). The coxcombs, elegantly dressed, wore turned up boots with the edges ornamented with lace. The boot makers became important persons, and many of them were reckoned among the artists. There resulted a genuine emulation, and, each desiring to surpass the others, magnificent boots were soon seen (Fig. 33). At Paris, the courtiers wore over their top boots galoches that they took off upon entering. At this epoch lace disappeared from the top boots and was worn upon the knees. During this great success of the boot, the shoe was worn scarcely anywhere, except in the country, but it came into great favor again in the Parisian drawing rooms when Louis XIV. no longer led his troops in person upon the field of battle. Fig. 34 shows a shoe of this epoch.

Top boots, still worn by generals, mounted troops and young students, were replaced in 1670 by low shoes provided on the instep with a very stiff and very showy lace bow (Fig. 35). It was also at this epoch that silk stockings were in great favor.

In the eighteenth century, the epoch of antiquated styles, the men wore the buckle shoe (Fig. 36), and the ladies the silk or white satin shoe.

The cavalry of this epoch wore the topless boot, and the infantry wore shoes, stockings and gaiters extending above the knees. A classical example of the high heeled shoe is the embroidered Venetian slipper (Fig. 37). With the advent of the so-called Werther costume (1780), the top boot again came into favor. The men of the Revolution wore it (Fig. 38), as did the *Incroyables* of the time of the Directory (1795–99), while the ladies, rejecting the high heeled footwear, adopted the flat, open shoes with crossed ribbons that were still in fashion during the first thirty years of this century.

After 1820, trousers came into fashion for men, and this naturally led to the shoes free from ornament that are still worn in our day.

We have just reviewed the somewhat lengthy history of footgear, from the Pharaohs down to our time. It only remains for us now to cast a glance at the peculiarities of certain European foot coverings, and to occupy ourselves briefly with the people of the East and with certain tribes of the New World.

The present shoes of the Italians of the Abruzzos (Fig. 39), as well as those of the peasants of eastern Russia (Fig. 40), recall those of the ancient Germans already described. But they are laced higher and more artistically among the Italians than among the inhabitants of the plains. The reason is simple: The mountaineer needs stronger footgear. The Spanish gaiter shown in Fig. 41 forms a covering for the leg which is both handsome and practical. These gaiters are embroidered and ornamented with lace.

Among the Mohammedans it is customary to take off the shoes upon entering the mosque or a house. The words addressed to Moses, "Remove thy shoes, for the place in which thou art is holy," has still the force of law in the East. We ought not to be surprised, then, that in the Levant, and particularly among the Mohammedans, but little importance is attached to foot coverings.

Among the Turks and Persians, the shoe is low and scarcely covers the toes. The heel is supported by a small counter, and the shoe terminates in a point in the form of an upturned beak (Figs. 42 and 43).

The Hindoos use a different shoe, which recalls both the European and Oriental foot covering. In the country of the Ganges and the Indus we find again the shoe, "a la poulaine," slightly transformed, worn by the princes (Fig. 44), then the wooden sandal for persons obliged to walk in the streets (Fig. 45), and finally the anklet (Fig. 46) worn by young girls.

The Japanese make use only of a wooden sandal. It leaves the foot of its natural form. Among the Chinese, on the contrary, an æsthetic aberration of the mind has led to a horrible distortion of the feet of the women. The shoe (Fig. 48) is naturally in keeping with the form of these mutilated feet. In China, the men wear a shoe whose form recalls that of a boat (Fig. 49). In this country, very little leather is used for the shoe. Its sole is of felt and the top of cloth.

The Aztecs, a people whose original civilization was crushed by the Spaniards, wore a special foot covering (Fig. 50) that somewhat recalls that of the Greeks.

The sabot or wooden shoe (Fig. 51) used by the French, Belgian and Rhenish peasants constitutes a very peculiar form of footwear designed before everything else to be impermeable. As a general thing it is made of a light wood, poplar, for example, and, as it is before all else a practical foot covering, little attention is paid to its beauty.—*La Science en Famille.*

* Continued from SUPPLEMENT No. 943, p. 15073.

WHAT WE KNOW OF THE LOBSTER.

By FRED MATHER.

WITHIN the past five years we have learned much of the life history of the common American lobster that is new, the most important item being a discovery of its spawning habits, which will simplify our attempts to hatch this valuable crustacean on a large scale. We knew that the female lobster carried a mass of eggs under her abdomen or "tail," as it is improperly called, and that they hatched there, or that we could hatch them under proper conditions of temperature and density of water, and there our knowledge of lobster propagation ended. There are many other things about the life of the lobster that are not popularly known, and without going into a technical description of its anatomy, we may find much to interest us in its habits, development, mode of reproduction and other incidents, from its emergence from the egg to its capture for market, where we will leave it to the mercies

of the *chef* and the lesser deities who preside over our kitchens.

To begin at the beginning is difficult. It recalls the old problem, "Which was first, the egg or the hen?" But in order to break into the life circle we will begin with a small lobster of a few months old, say in September. The temperature is lowering and no more growth is to be made until next year; therefore a gradual movement toward deeper water is begun in order to be beyond reach of the rapidly cooling waters near shore and to get below the influence of frosts, as the tortoises, frogs and some of our land mammals do. At this time our young lobster will measure from one to two inches, exclusive of the claws, according to the circumstances of food and the date of hatching, the latter being entirely a question of temperature. Living at a depth where there is sufficient warmth to sustain life, but not enough to rouse much of an appetite, our young lobster lives through the winter without making any growth, and in the spring crawls up, as the waters warm, into the shallows and begins to feed on such animal forms, alive or dead, as may come within its reach.

Incased in a hard, unyielding shell which does not grow, it may be compared to a knight in armor, who would be obliged to get a new suit if he should outgrow the old one; therefore, after accumulating a store of material for growth, the shell either splits up the back of the carapace or the latter separates from the first ring or segment of the abdomen and the hinder portion of the animal is withdrawn, and then, with great labor, the forward parts follow and the lobster lies soft and helpless, a toothsome morsel for any predatory fish that may chance along; but instinct teaches the lobster that down among the crevices of the rocks is a sanctuary, and there it remains for several days until the skin hardens into a new shell and it can again fearlessly face its enemies in search of food. It has been my fortune to witness this operation several times while connected with the New York Aquarium, Thirty-fifth Street and Broadway, in 1876-78, and twice since in lobster cars in Vineyard Sound, and it is wonderful what a great increase in size takes place at once after the animal leaves its shell. Another wonder is how the great claws are drawn through the very small joints, one or two of which split lengthwise while others seem to soften and expand enough to permit the passage of the claws. When we realize that the lining of the stomach is attached to and cast with the old shell, it will be seen that the change of armor is a complicated and difficult process, not unattended with danger. The new shell is often to be seen under the old one, and then the lobster is in the same condition as the "shedder" crab, so eagerly bought by salt water anglers for bait, the body being somewhat shrunken from the shell. After casting the shell, the lobster resembles the "soft" crab, which is so esteemed by the epicure that they are sold at many times the price of the "hard" crab. These names apply to the common edible or "blue crab," of the Atlantic coast, at different periods of growth.

There is a singular prejudice among lobstermen against eating a soft lobster which does not extend to epicures. I have eaten of them when soft, and think them excellent; surely, the animal is fat and in prime condition or it would not shed preparatory to taking on greater size. Just how long it may take for the new shell to harden may depend on temperature or other conditions. One in the New York Aquarium, in summer, became quite hard in about twenty hours, and took food the third day after shedding. There seems to be a provision of nature that the female shall not cast her shell until the eggs are hatched, otherwise they would be lost, as they are greedily devoured by eels and other fish. As an instance of this, I will cite the fact that the law of Massachusetts forbids "berried" lobsters to be sent to market. The honest lobsterman, therefore, puts such a lobster in a car which has holes large enough to admit eels, and in twenty-four hours she can be sent to market in compliance with the law, for she will have no eggs left.

I have purposely skipped from the little lobster that we left foraging on his first spring campaign to the habits of the adult, which are the same, because we know nothing of the rate of growth beyond the first season. We know that lobsters shed their shells at irregular times during most of the year, more frequently in the warmer portions, and that this only occurs because the creature is growing and its armor is not large enough. Just how old a marketable lobster of two to ten pounds may be, no man knows, and such knowledge could only be obtained by rearing them in confinement, and then it might not be conclusive under different circumstances of food and temperature, and the casting of the shell forbids marking individuals.

The female spawns but once in two years. Notes made on the eggs of lobsters in the New York Aquarium show that they hatched before July, or when the water reached a temperature of *about* 60° Fah. In 1891 I began the hatching of lobsters for the New York State Fishery Commission, of which I am one of the superintendents, and found that eggs taken from lobsters from the middle to the last of July did not hatch that year. Then it seemed as if the lobster might be a biennial spawner, but I did not dare to say so. A report of my observations sent to Prof. Samuel Garman, of the Museum of Comparative Zoology, Cambridge, Mass., brought a letter dated Aug. 30, 1892, complimenting my studies on the life history of the lobster and inclosing a printed report to the Massachusetts Fish Commission, dated Dec. 17, 1891, in which he shows that his investigations proved that the lobster spawned but once in two years. Therefore, I have solid backing in making the statement that heads this paragraph

Since this I have taken, for the New York Fishery Commission, a large number of lobster eggs and have turned out this year from Cold Spring Harbor, Long Island, 177,000 young lobsters into the waters of Long Island Sound. These were from eggs which otherwise would have been sent to market with the parent and have been boiled and thrown away with the shells, and were therefore just so many saved from destruction, and given a chance to struggle for life. There is no law in the State of New York relating to "berried" lobsters, and from what is said above of the Massachusetts law, it does not seem that one would be advisable, unless so framed that the lobsterman should take the eggs from the lobster and either keep them in a place where they would hatch, or better yet, save them for an agent of the fishery commission who could collect them at intervals, and would reward the lobsterman sufficiently to make him interested to turn in as many good eggs as possible.

The eggs, which, as before said, are carried on the appendages under the abdomen, number fifteen to the linear inch, and measure 6,000 to the fluid ounce, are attached not only to the swimmarets, but also to each other by threads, and are aerated by an almost constant motion of the appendages, and in confinement many eggs are loosened and fall off, perhaps from the habit that the parent has of poking among them with her legs. In the spider crab this poking is not only frequent, but the eggs are eaten by the parent, at least when in confinement, but I have never seen a lobster eat its eggs. It has been said that lobsters spawn at all times of the year. This is not so, for the reason that they are not as active in winter and do not feed as much as in summer, and also because the young do not hatch until the water reaches a temperature of about 60° Fah., which in Long Island Sound might occur after the latter part of May, and in that region the hatching season is over by the middle of July, and as the mother has been feeding while carrying her eggs, she can then shed her shell and begin to develop the so-called "coral" that epicures prize, which will form the eggs to be laid the second year. The fact that female lobsters bearing eggs outside while others have the coral inside are taken in winter supports the theory of biennial spawning. On August 16, 1893, I took a lobster from a car which the owner told me had spawned two days before. The microscope could detect nothing in the eggs, because the yolk filled them entirely. Four days later the yolk had shrunken and the "mulberry" stage could be seen in the clear space, and by the 25th the eye was visible. The eggs are dark when first laid, and grow lighter in color as they develop. From this until October no change was seen. The water growing cooler, the mother did not take as much food as before, but seemed to be as pugnacious as ever, showing fight to any one who approached the glass. At present writing she is living in a tank about 12 × 18 inches and may live all winter.

She had been plugged in the claws to prevent danger in handling, as is usual, but I removed the plugs, and she can now use her claws as well as ever.

When our little lobster comes from the egg an inexperienced eye might easily suppose it to be a young shrimp or any other crustacean, for, unlike its fresh-water prototype, the crawfish, which at hatching resembles its parent in everything but size, the young lobster is in an embryo or larval state, as much so as an embryo trout, which has no resemblance to its parent. It moults perhaps four to six times during the first ten days of its life and makes, according to Prof. S. I. Smith, of Yale, three changes of form in this time before getting the large claws and assuming the shape of its parents. They swim throughout all these changes and perhaps long after, which makes it certain that a plant of young made at a particular spot may be repeated many times without danger of overstocking that locality, for as they swim away the tides and currents scatter them, and when the time comes to settle down to steady habits they are wide apart. Still, as the plantings made by me for the New York Fishery Commission were all made at Cold Spring Harbor, on the south shore of Long Island Sound, some fifteen miles west of the middle of that body of water, the varying tides would not take the little swimmers outside its limits, because the returning tide would bring them back again. Therefore there is no doubt about the value of saving the lobster eggs and planting them in the Sound. Of course, some of the New York lobsters may cross the Sound and be taken in Connecticut traps, just as New York salmon and shad are taken by fishermen of New Jersey, but that is not a thing to be considered seriously.

A very natural question for a reader to ask at this point is: "Why don't you retain the youthful lobster until it ceases to swim and settles down to crawling, and thereby stock a certain district in which your State, that pays for the work, is interested?" To this I should reply that in theory that would be the proper and most correct thing to do, but in practice we find that there is a factor that will not be left out of our calculations, and this factor is cannibalism.

There is, at present writing, no food for a larval lobster known to me that is as acceptable as another larval lobster that has just moulted. I have tried to bribe them by hanging flesh of eel, clam, beef, lobster (adult), blue crab, and fiddler crab, but without avail; their love for their fellows which prompted them to take their brethren in out of the wet, lest they might be devoured by small fishes, baffled my efforts, and there was no resource but to plant the fry as soon as hatched. If each youngster could be placed in a tank or even a small compartment by itself, no doubt it would accept any, or all, of the foods named, but at present we are not prepared to feed a million or more individual lobsters in separate stalls for months before turning them out to shift for themselves. They cannot be reclaimed from cannibalism by any known means. They are fighters by nature, and when a lobsterman has a lot of adults in a floating car and a storm comes up, each lobster blames his neighbor for any collision that may ensue and they engage in a general fight, which is not only disastrous to themselves but to the lobsterman, for lobsters are not marketable in fragments.

The size of marketable lobsters has been on the decrease for the past fifty years. Half a century ago my father never brought home a lobster for family use under six pounds, and it was often twice that weight. One under six pounds was not thought worth picking the meat out of, for the labor is the same, no matter what the size; but to-day a two-pound lobster is considered of good size, although an occasional "deep sea" lobster of twenty pounds, or more, is seen on the stands. These usually have large barnacles, oysters or other animals of good size attached to their shells, showing that they have not moulted in some years, and their claws are always bruised and blunted as additional evidence that their armor has not been recently renewed. The taste for "chicken" lobster has done much in recent years to kill off the young and to prevent their attaining a larger size, but the canneries are credited with taking in all that may be rejected by law. The State of New York had a law that no lobsters measuring less than ten and a half inches, exclusive of claws, should be sold. This excellent law was, I believe, obtained by Mr. Eugene G. Blackford when he was president of the New York Fishery Commission, but was repealed at the instance of State Assemblyman Flinn, who desired to serve chicken lobsters at the free lunch counter in his liquor saloon.

That lobsters of twenty pounds weight have been taken within a few years I know, for I have seen them weighed; but the monsters of twice that weight that we read of are not well authenticated, and the story of the judge who, after the manner of Solomon, decided a bet on the weight of these crustaceans against the man who brought sworn testimony of old fishermen, who remembered lobsters of forty pounds, by saying "affidavits are not lobsters," has passed into history. A century hence, my statement of having seen a twenty pound lobster may be received in the same way, and some judge, yet unborn, may paraphrase the above decision, and solemnly declare that "statements are not lobsters."

A curious thing about a lobster is the difference in its claws. One is thick and blunt and the other is long and slender. One seems to be for crushing hard objects and its mate seems formed to hold them. This is the case with every individual, but there are right-handed and left-handed lobsters. Some years ago Mrs. Mather painted lobsters surrounded by celery, oil, vinegar, and all the necessaries for a mayonaise, but one of the lobsters had the big claw on its left. When allowed to see it, I remarked that there was either a mistake or her specimen was abnormal. She insisted that the original must have been so, and on my next visit to Fulton Market, where over a hundred lobsters were handled for my edification, I found that a lobster might be either right or left handed without violating any rule, and then made my apologies to the artist. The color of lobsters sometimes varies from the ordinary olive-green, with reddish tints on the claws, to red all over, and a mottled coat is quite often seen. The red ones are quite rare, and the few of this color that I have seen have been lighter than the boiled lobster, sometimes with a yellowish cast. The cause of these variations is not known.

The lobster feeds upon animal food exclusively, for its digestive system could not assimilate vegetation. Its stomach is a sac, just behind the mouth, and has no other opening, save the small pores through which the digested portion of chyme or chyle is filtered into the thorax, there being a space of some inches between the stomach and the only intestine, or drain tube, which begins at the first segment of the abdomen and runs without convolution to the cloaca. The stomach is fitted with rough, bony plates to masticate the food, and when opened shows a fanciful figure called "the lady in the chair." All bones and undigested portions are ejected through the mouth. In dressing a lobster for the table, the so-called "poisonous parts" are rejected. They are the stomach, which could not be eaten, and the vein-like intestine spoken of. To remove the latter it is only necessary to split the abdomen, or so-called tail, lengthwise, when it will be seen as a greenish thread. All other parts are eatable, and the tender, green "fat" in the thorax, and the delicate, white "fac" lining its shell, should never be lost, as they contribute both flavor and digestibility to the harder portions.

The lobster does not range far south on our Atlantic coast, because it is sandy south of New Jersey, and does not afford protection for them when in the soft state, even if other conditions were favorable. Large individuals are sometimes taken on the coasts of Delaware and Maryland, and they range as far north as Labrador, the best lobster grounds of the Atlantic being Nova Scotia and Maine. They were formerly abundant in Long Island Sound and about New York harbor, but the pollution of the waters, especially with "sludge acid," from the petroleum works, has driven them away. This abominable stuff does not drift far, but settles on the bottom, and, while it may not disturb the shad and salmon, which are migratory, it kills out the oysters, clams, mussels, snails, and all those forms that live on the bottom, including the lobster, and compels the fishes which seek food in those waters to go elsewhere. The canning of small lobsters in Maine may affect the product there, but the worst of all enemies is man. Of all the destructive agents to animal life of most kinds, man stands at the head, at once the wisest and most ignorant of all animals. His ignorance is especially in contrast with his intelligence, when he deals with other creatures. And the lobsterman is an instance; he wants to see lobsters plenty, because he finds a ready market for all he can get; but, when he raises a lobster pot and finds that two or three small lobsters of four or five inches in length have ventured to eat the whole or part of his bait, he is angry, and, instead of returning them to the water to grow, he mashes them on the bottom of his boat. As well might the farmer shoot his young fowls for eating his grain! The lobster will eat fish, clams, mussels, and other animal food, fresh or stale, but in the pots a fresh bait is more attractive, and the lobstermen use almost all kinds named for bait, and could, with small expense, so make their traps that, when a lobster entered the pot, it could not devour the bait, and so afford to let the young go free if the larger ones did not devour them in the pots.

The power of the lobster to reproduce a leg or claw is well known. It is not done until the next moult, when the new limb appears as a very small model of the original, but after a few changes of shell the claw is restored to its normal size and usefulness. The animal can and does cast a claw when frightened, especially in cold weather, probably to satisfy its captor with a portion instead of the whole—a tub to the whale, as it were. The claw is snapped off with a jerk, as if to say, "Take this and let me go." The lobsterman never lifts the animal by its claws for this reason, but grasps it by the thorax, leaving the large claws to hang down or turn up in a vain attempt to pinch his hand.

Our friend has two means of locomotion. When in danger it can go backward rapidly by means of a few vigorous flaps of its tail, but ordinarily it crawls forward on the bottom, holding its large claws well up. If left in a pool by the receding tide, it would stay there and perish before trying to go overland to the

sea, even if not ten feet away.* When taken from the water the lobster is very helpless. Its specific gravity is great; its enormous claws cannot be lifted in air, and when laid on the market slabs it remains where it is placed from sheer inability to move.

Just how the eggs are impregnated is not known. It is said that the milt is placed near the oviduct some time before the extrusion of the eggs, and that they are fertilized by passing over it. Of this I know nothing, and merely insert this paragraph to show that this question was not overlooked. The sexes of lobsters can easily be distinguished without the presence of eggs, but it is no part of my purpose to enter into the realm of anatomy or theory, as the title of this paper is "What We Know," etc.† When the pairing takes place and how it is performed no man knows. A study of the reproductive organs has developed a theory, and there we stop.

The increase of population has naturally increased the consumption of lobsters, and the great decrease in the size of this crustacean, referred to above, is an evidence that they are slow of growth, and the marketable lobster of to-day, weighing from one to two pounds, may be from four to six years old, possibly more. In all these estimates of weights a fairly plump, well-fed lobster is meant, and not one that would be rejected by the housewife as not worth picking the meat from, for she has learned to weigh them in her hand, and of several of the same size, to choose the heaviest.

We hope to increase the supply of lobsters by saving the eggs from destruction, but the ever-increasing demand for them will prevent their becoming cheaper in the markets.

[FROM THE SUN, NEW YORK.]

THE HAWAIIAN ISLANDS.

IN the central regions of the northern Pacific is a long and narrow submarine bank, extending about 2,300 miles nearly northwest and southeast. The waters over it are from a few hundred to 6,000 feet in depth. The northern and southern slopes are quite precipitous, sinking abruptly to oceanic depths. Here and there along this bank volcanic vents were opened, in some past age, and the great outpourings of lava were finally lifted above the sea level, adding new islands to the ocean. About sixty of these islands, most of them small, were raised along the bank, and around many of them the polyps lived and died, and their remains are embedded in coral reefs.

The narrowest part of this bank is its eastern end, but, strange to say, on this most inconsiderable portion the largest islands are reared. They form the Hawaiian group, and the greatest of them, Hawaii, is near the extreme eastern end of the bank. An hour or two of steaming from any port on the islands takes a vessel into waters of oceanic depth. A half day's voyage takes the vessel into waters as deep any in the Pacific, except the abysses east of Japan and the Challenger and Miller deeps.

There are eight inhabited Hawaiian Islands, besides five bits of rocky expanse that are hardly large enough to be turned to any account. We observe some very interesting things about these islands. The movement of waters around them is remarkable. The islands lie in the northern edge of the north equatorial current which flows so steadily westward: and a little north of them there is, if not a well defined current, at least a tendency of the wide surface expanse of waters to drift eastward. The result is that flotsam and jetsam, both from America and Asia, find lodgment on the shores of these islands. Pine trees from the coasts of Oregon or Vancouver Island are often stranded on the archipelago. Native traditions have handed down reports of red men from the far east whom some chance cast upon the islands. Men are still living on Oahu who remember when four poor Japanese survivors of a party of nine reached their coast, more dead than alive, and told of the terrible ten months' drift that had carried them thousands of miles over unknown seas. "Now we know we came from Asia," said the Hawaiians, as they recognized the resemblance between these castaways and themselves.

The area of these islands is 6,640 square miles. The largest island, Hawaii, receives a far greater quantity of rain than the other islands, because it lies more directly in range of the windward storms, and yet no streams are found carrying the water to the sea except along the northern coast fringe. The rains disappear quickly through layers of volcanic ashes, reaching the sea by subterranean courses or sinking deep through the strata and turning into steam to add terrible power to the never-resting plutonic forces.

Active volcanoes, the world over, have various claims to distinction. Cotopaxi is the most lofty active volcano. Sangai, also in the Ecuadorian Andes, is the most active. Hawaii has the greatest volcano in the world. The volume of lava pouring out of Mauna Loa has been sufficient in a single eruption to build up another Vesuvius. A little east of Mauna Loa is the volcano of Kilauea, whose oval crater, nine miles in circumference, is the largest active crater known; and then on the neighboring island of Maui is the dead volcano Haleakala, whose crater, covering an area of sixteen square miles, is the largest on the planet as far as we know. These volcanoes, living or extinct, are among the wonders of the world. Every ten days a steamer leaves Honolulu to carry tourists to Mauna Loa. The round trip takes a week, and costs only $50. These volcanic forces, which are still so active on the island of Hawaii, became extinct many ages ago in the more western and smaller islands. Their craters, worn away by ages of denudation, are most of them unrecognizable now. Vegetable mould, mixed with pulverized lava, has covered the once molten lava streams with verdure. Warm springs feebly represent the volcanic phenomena that were once so predominant. Some crater pits, however, are still very noticeable. One of them is the Punch Bowl, seen back of the town as vessels enter Honolulu Harbor, another is the famous Pearl Harbor, a little further west, where vessels may steam right into an ancient crater, through whose broken outer wall the sea pours in.

Somehow or other human beings reached these eight volcanic islands, where they became very numerous. A hundred years ago, probably 200,000 of them lived there. When Captain Cook discovered them in 1772, he estimated their number at 400,000, but this was a great exaggeration. They were then, and their descendants are to-day, the finest specimens of the Polynesian-Malayan race. They are a copper-colored, handsome, well-built, intelligent race, as capable of reaching a high level of civilization as any aborigines who ever enlisted the services of missionaries; but they are still children, and still need the guiding hands that have led them so far.

Living on the northeastern outskirts of the Polynesian world, and without traditions showing that they have held their kindred far south and west of them in remembrance, they speak practically the same language as the natives of the Society Islands. Separated by thousands of miles from New Zealand, they and the people of those islands can understand one another. This is one of the wonders of human migration, and perhaps the world will never know how these widely scattered peoples, who so plainly belong to the same region and family, were so widely wafted over the vast expanse of ocean to find new homes in the islands that are scattered over it.

There is no doubt that long before Cook found the islands the Spaniards knew of their existence. In the early days of maritime discovery, however, the Spaniards were not giving away much geographic information. Cook called the archipelago the Sandwich Islands, after an English nobleman. Much to the delight of the educated natives of to-day, the islands are now very well known by the name of the largest of them. The name Sandwich Islands is likely to fall into complete disuse. It wounds the pride of any intelligent native to hear his country referred to by the name that Captain Cook gave it.

In many natural aspects these islands have changed greatly within a hundred years. The flora and fauna of the little archipelago, nearly 500 miles long, has been greatly enriched by the outside world, and particularly by America. The islands are not naturally so well endowed in these respects as might be supposed from their favorable position and fertility. Cook saw cocoanut and bread fruit trees along the coasts, but vegetation was rather sparse, except in the deep, well-watered valleys. The food products that now form the agricultural riches of the islanders were nearly all introduced by American missionaries. The natives also had few varities of mammals. A hundred years ago the dog, the hog, and the fowl were the only domestic animals. Now horses are in abundance, cattle raising is, in some districts, a profitable industry, and a single American has 75,000 sheep on the most western island of the group. Cattle that escaped to the mountains now live wild and are hunted for sport and food. The natives often dig pitfalls for them, and years ago, newspapers all over the world told of the sad fate of a botanist who went out for scientific study and lost his life by falling into a hole where he was gored to death by a bull that had stumbled in before him.

Great as the change has been in the floral and faunal aspects of the islands, it cannot be compared with the mighty changes in the people themselves. They were in no way superior in ideas and morals to other Pacific island savages when the whites first met them. Polygamy was common. Women were in a condition of inferiority. Infanticide was practiced. Human sacrifices were a feature of idolatrous rites. Cannibalism, to some extent, was in vogue. Such a thing as virtuous womanhood was not known, and there was no word in the language to express it.

To-day there is not a native Hawaiian over seven years of age who cannot read, write and cipher. Education is compulsory. American missionaries made the conquest of the islands. They went to the barbarous people seventy-three years ago, and in a few years not a vestige of faith in the old heathen beliefs remained. Protestantism, mostly of the Congregational type, is the religion of more than half the natives. There is, however, the widest religious tolerance. The Chinese worship in their joss houses. French Catholic priests have been active. They have a following of 20,000 people, over half of whom are Portuguese immigrants, who have flocked to the islands in large numbers. The natives are quite hardy and fairly industrious, but after all they are pleasure-loving, easy-going Polynesians, with little of the moral stamina and perseverance that mark the stronger races. They are not fitted for self-government, and a pathetic fate awaits them.

In spite of better food, clothing, and habitations, they are dying out. The sad fact seems to be beyond remedy. In fifty years more there will probably be few pure bloods on the islands. There is and will continue to be a large admixture of the Hawaiian and other races. The number of men greatly exceeds that of the women—an anomalous condition, for women the world over are usually in the majority.

The curse of the islands is leprosy, which was introduced by Chinese immigrants in 1848. To-day about one native in fifty is afflicted with the malady. A large part of Molokai Island is reserved for these unfortunates, 800 in number, whose unhappy fate it is to be severed from their homes and friends until death relieves their sufferings. Years ago the government placed a strong, healthy man, who had been condemned to death for murder, among the exiles of the leper colony, telling him that, if he did not contract the disease within a certain time, he would be pardoned. Many of the people had protested that leprosy was not infectious, and that it was a needless cruelty to isolate the sufferers; but it was not long before the strong man became a hopeless leper himself. Since his death there has been no question that it was wise to maintain the leper colony.

In 1889 there were 92,050 people in the eight Hawaiian Islands. Less than half of this number, or 42,500, were native Hawaiians or mixed breeds. All the others, except 500 natives of other Pacific islands, were Americans, Europeans and Asiatics. It may surprise some people to know that of the 19,000 whites whose homes are in these islands fully two-thirds are Portuguese. The dwindling of the native populace and the great development of sugar growing and other industries made it necessary to procure more labor than even the Chinese and Japanese, who were coming by thousands, could supply. One day the happy thought occurred to an American that it might pay to invite natives of the crowded Azores to go to Hawaii. About 270,000 people live in these little Atlantic islands. Many of them were not averse to trying their fortunes on the other side of the world, where, it happens, they have found in their new homes, at the end of an 8,000 miles journey, almost the same soil, products and climatic conditions as those to which they had been accustomed all their lives. They make honest, faithful laborers, and are so well pleased with their prospects in the few Hawaiian towns and on the sugar plantations that they keep sending for their friends; and so it happens that although the natives are decreasing at the rate of about 1,000 a year, the population of the islands shows a handsome growth at every recurring census. There were 18,150 white people in the islands in 1889, of whom 3,000 were Americans. Our nationality outnumbers the representatives of all the European nations put together except Portugal.

The country has only a few important towns, and Honolulu, with its 25,000 people, is the metropolis of the western Polynesian world. It was an American skipper who discovered the harbor that has made the port of Honolulu what it is. Good harbors are few and far between in these islands. There is hardly a respectable harbor except at Hilo in Hawaii, and Honolulu and Pearl harbors in Oahu. The coasts rarely have deep indentations. Wherever a settlement is on the coasts, a fair anchorage or roadstead is usually found. Many of these little settlements are seen along the shores of Hawaii, but they are nearly all hamlets, containing only a few houses and a shop or two. The only town of much importance in the whole island is Hilo, and a fine settlement has grown up on the shores of the little bay. Hilo has about 6,000 inhabitants, and its importance will gradually increase if the lava streams from Mauna Loa continue to stop short of the settlement. Lahaina, on the south side of the island of Maui, has a roomy and sheltered roadstead, and the houses of its 4,000 people are half hidden among groves of cocoanut and other tropical trees. Another town, Wailuku, of about the same population, but commercially more important, is on the north side of the island. Foreigners live in both these towns, which derive their importance chiefly from the sugar plantations.

The best anchorage in the island of Kauai gave rise to another town of some importance, Waimea, which has the distinction of being built on the banks of a river that can be navigated for nearly a mile, about the only internal navigation in the islands. It is on Kauai that the famous singing sands are found, and scientific men have traveled all the way from this country to discover the secret of their sonority. It was found, when the grains of sand were examined with a microscope, that they contain cavities, and it is supposed that these minute hollows are the cause of the resonance, for when the sand is wet the noises are not heard.

Oahu is the spot that nature has most favored. Fringing its northeast side is a range of mountains whose summits catch most of the precipitation and send it in torrents down the slopes to water the plain that forms most of the island. The east side of the mountains is comparatively dry and barren. The west side and the great plain at the foot is brilliant with sub-tropical verdure and one of the garden spots of the world. Lower hills also border the western coast of Oahu. A broken coral reef surrounds the larger part of the island, and this reef helps to make the fine natural harbor of Honolulu. Here all the comforts and most of the luxuries of life may be obtained. Daily newspapers, good schools, a college, an excellent library, street cars, and electric lights are among the advantages. There is a good deal of wealth in the town, most of it in the hands of American settlers. The society is refined and cultivated. A more delightful place of residence could hardly be imagined. There are few uncomfortable days; the mean annual temperature is that of the more pleasant parts of Florida, and the climate is very healthful. Far and wide over the undulating plain of Oahu are the big sugar plantations, and sugar and rice are also extensively grown on some of the other islands. They are the chief industries, and there is still room to greatly expand them. Coffee, hides, bananas, and wool are next in importance in the exports of the islands.

The United States has done far more than all the other nations combined to make the Hawaiian Islands what they are. No wonder that they excited our early and persistent interest. They form the nearest approach to America of the Polynesian island world. We can reach them in a week, but they are three and four weeks' distant from all other great nations. Our missionaries were the pioneers of civilization. In proportion to its size, no part of the world, reclaimed by civilizing influences, has had so much written about it and for it; and four-fifths of this literature is the product of American pens. Our missionaries have lived there seventy-three years, and their children and grandchildren are to-day among the most prosperous and influential residents. Not a few names of men now known as active in the revolutionary movement have figured most prominently in Hawaiian history. Their families for many years have been wholly devoted to various phases of progress, and we now see them committed to the cause of insuring good government. This is the only blessing the islands need to give them stable and increasing prosperity. It is interesting to trace the ways in which these families have been identified with the good of Hawaii. Mr. Dole, for instance, is at the head of the present Provisional Government. It was an earlier Mr. Dole who, as one of the side issues of his work, made comprehensive studies on the zoology of the islands, and published the result.

The Americans control most of the Hawaiian trade. In 1884, 239 ships entered the port of Honolulu. Of these 191 were North American, 29 British, 4 French, 4 German, and the others were engaged in the Hawaiian local trade. Since then the fleet trading with Hawaii has been considerably increased and the same proportions are maintained. The fostering care of our government has wonderfully developed Hawaiian trade and industry, and our reciprocal treaty give us practically a monopoly of Hawaiian commerce. Our teachers have fostered Hawaiian education; and in 1878 the Universal Exposition of Paris awarded to the islands

* See Eighth Report New York Fish Commission, 1875, page 23, tenth to eighth lines from bottom.

† See "Fisheries Industries," section 1, pages 795, 809.

the Grand Prix for best results in the development of primary instruction.

It is American money and protection that has advanced the culture of sugar and rice by leaps and bounds, that has built the sixty miles of railroad, and spread the telegraph everywhere. Ninety-one per cent. of Hawaiian external commerce is with this country. The schools are modeled after ours. The school books are American. Our gold and silver coins, together with Hawaiian coins, are the only legal tender. Our measures and money are those of the Hawaiian people. Our government determined latitudes and gravity for the Hawaiian government and published the results. An American owns the whole of one of the eight islands, Niihau, and raises many thousands of sheep and cattle there. Another wealthy American, C. R. Bishop, who owned about one-half of Molokai and had his land well stocked with cattle, sheep, and horses, has just made a splendid gift to the people, having transferred this entire property in trust, the income from it to be devoted to educational purposes.

"The Hawaiian Islands," wrote the geographer Reclus, in 1889, "are really a province of the American republic." As a matter of fact, most of the potentialities of these islands are yet undeveloped. The people themselves and the outside world have only just begun to tap their resources. American self-sacrifice, energy, and capital have done what has been done, and all Americans have reason to be proud of the results their compatriots have achieved in seventy-three years.

DUST AND ATMOSPHERIC PHENOMENA.

By Dr. J. G. MCPHERSON, F.R.S.E., Lecturer on Meteorology in the University of St. Andrews.

AT a recent meeting of the Royal Society of Edinburgh Mr. John Aitken read a most interesting and important paper on "Dust and Atmospheric Phenomena." It was a continuation of the investigations made in 1889, which I abridged in these columns in October, 1890. During 1890 he went over the same ground under different atmospheric conditions. He first visited Hyeres, where by his famous instrument he counted 250,000 dust particles in a cubic inch of the air, whereas on the former visit he counted only 12,000. He observed, however, that where there was least dust the air was very clear, whereas with the maximum of dust there was a very thick haze.

At Mentone, the number of dust particles in the cubic inch was 13,000 when the wind was blowing from the mountains, but increased to 430,000 when the wind was blowing from the populous town, where the air was more polluted. At Bellagio the result was similar. With the smaller number the air was clear and brilliant, with scarcely any perceptible haze on the hills; but with the larger number there was a thick haze, the distant hills being quite invisible. After a series of observations there, with careful examination of the temperature by wet bulb as well as dry bulb thermometer, he came to the conclusion that the increase in the number of dust particles accompanied by constant humidity is accompanied by a decrease in transparency; and that the increase in humidity is also accompanied by decrease in transparency, if the number of dust particles remains constant.

When Mr. Aitken first visited the Rigi Kulm, in Switzerland, the air was remarkably clear and brilliant, and the number of dust particles per cubic inch never exceeded 33,000. On his second visit, in May, 1890, he counted no less than 166,000—about five times the number; this was accompanied by a thick haze, which rendered the lower Alps scarcely visible. The thickness was not due to humidity, for the wet bulb was depressed 10°, therefore the air was very dry; but it was due to the number of dust particles suspended in the atmosphere. On looking down from the mountain to the valleys the air was, some time before sunset, so thick that the lower slopes of Pilatus were scarcely to be detected. This was due to a thick haze between the observer and the mountains, as if a veil were hung between him and the distant scenery. The upper limit of the haze was well defined, and though the sky was cloudless, the sun looked like a harvest moon and required no eagle's eye to keep fixed on it.

Next day there was a violent thunderstorm, which gave an opportunity of making observations at its different stages. At noon, when it was clear, the number of particles to the cubic inch was 66,000. At 6 P. M. the storm commenced and 60,000 to the inch were registered; but in the middle of the storm he counted only 13,000. There was a heavy fall of hail at this time, and Mr. Aitken accounts for the diminution of dust particles by the downrush of purer upper air which displaced the contaminated lower air. For the year before he observed the same change during a heavy fall of rain on the Eiffel Tower, when the number per cubic inch was as low as 3,000.

He next showed, from a reference to the general circulation of the wind over Switzerland during the periods of observation, that when the number of particles was small during his first visit the general air circulation was from the Alps; and, on the second visit, when the number was great, the movement of the air was from the inhabited parts. He also found that on the day of the storm the diminution of the number of particles was concurrent with a change in the direction of circulation, which brought pure air from the Alpine region, and it was when the pure air and the foul air began to mix that the storm broke.

But the most remarkable set of observations was made on the Lake of Lucerne. In the course of an hour there was an exceptional diminution in the number, which made him think that something had gone wrong with his instrument. At 3 P. M. he counted 171,000 in a cubic inch; at 3:45 the number was reduced to 28,000. During the interval the thermometer had risen from 71° to 75°, and the wet bulb depression varied from 11° to 19°. On looking about he found that the direction of the wind had changed, bringing down the purer upper air to the place of observation. The rapid change in the direction of the lower current of air was caused by a southwest wind striking the face of the mountain, which was there nearly vertical.

The bending downward of the trees by the strong wind showed that it was coming from the upper air. At 4 P. M. the thermometer fell to 68°, and the wet bulb depression was 10°; he counted 204,000 particles in the cubic inch—a most remarkable result—but the old conditions were restored by the reversal of the wind.

Returning to Scotland, Mr. Aitken continued his observations at Ben Nevis and at Kingairloch, opposite Appin, Mr. Rankin using the instrument at the top of the mountain. These observations showed in general that on the Ben southerly, southeasterly and easterly winds were more impregnated with dust particles, sometimes containing 113,000 per cubic inch.

Northerly winds brought pure air. The observations at Kingairloch showed a certain parallelism to those on the summit of the mountain. With a northwesterly wind the particles reached the low number of 300 per cubic inch, the lowest recorded at any low-level station.

The general deductions made by Mr. Aitken from his numerous observations during the two years are, that air coming from inhabited districts is always impure; dust is carried by the wind to enormous distances; dust rises to the tops of mountains during the day; with much dust there is much haze; high humidity causes great thickness of the atmosphere if accompanied by a great amount of dust, whereas there is no evidence that humidity alone has any effect in producing thickness; there is generally a high amount of dust with high temperature and a low amount of dust with low temperature, and a high amount of dust reduces the transparency of the air.—*Knowledge.*

VENUS AND HER CRESCENT.

PROF. R. W. PRENTISS, professor of astronomy in Rutgers College, New Brunswick, N. J., comments as follows in the New York *Herald* on the unusual spectacle which the twilight sky now affords of the exceedingly bright evening stars Jupiter and Venus. He said:

"The phenomenon occurs at intervals of eight years, whenever the planet is at or near its greatest north latitude, and about four or five weeks before inferior conjunction, at which Venus is between us and the sun. Venus is now 33,000,000 miles distant from the earth, but by February 16, at inferior conjunction, this will have diminished to 25,440,000. Venus will then present to us a face entirely unilluminated, and will be lost in the brightest rays of the sun. Even now in the telescope it is seen to exhibit the form of a delicate crescent like the new moon and the quarter part of its disk being in the shadow, so that the brightness seems the more wonderful. After February 16 it will pass to the outer side of the sun, being visible in the early dawn as a morning star, and by November 29 its distance will have increased to 159,000,000 miles, when its brightness will be five times less than it is now.

"Jupiter, although separated from us by more than four hundred million miles, is yet the largest planet in the solar system and exceeds in size a thousand earths. It is the giant planet, and outshines the other stars in outline, in magnitude and luster. Venus, on the other hand, is about the same size as our own globe. Its orbit is almost a circle entirely within the orbit of the earth, so that at times it is between us and the sun, and at other times beyond the sun, its distance varying from twenty-five to one-hundred and sixty millions of miles.

"At present Venus is our nearest neighbor among the planets, and its nearness and high reflecting powers combine to make it most conspicuous. In fact, it is so brilliant it may be seen in a clear sky with the naked eye throughout the entire day by any one who knows just where to look for it.

"It is a little more than two hours behind the sun and a few degrees higher, and therefore may be found a little above the place the sun occupied in the sky two hours before. A few moments after two o'clock every day this week it will be on the meridian, half way up the sky, between the zenith and the south point of the horizon. In the morning hours, from ten to twelve, it is in the southeast at an altitude of about thirty-five to forty degrees.

"It is related by Arago that Napoleon Bonaparte, upon repairing to the Luxembourg when the Directory was about to give him a fete, was very much surprised at seeing the multitude which was collected in the Rue de Touron pay more attention to the region of the heavens situated above the palace than to his person or to the brilliant staff which accompanied him. He inquired the cause, and learned that these curious persons were observing with astonishment, although it was noon, a star which they supposed to be that of the conqueror of Italy, an allusion to which the illustrious general did not seem indifferent when he himself with his piercing eyes remarked the radiant body. The star in question was no other than Venus. Other instances of its observation in the daytime are recorded, some at a very early period—398 A. D., 984, 1009, 1014, 1715 and 1759."

AN EXPERIMENT WITH THE SCOURING RUSH.

THE scouring rush (*Equisetum hiemale*) is an interesting plant which has been put to practical use. In olden times its hollow, flinty stems were in great repute for kitchen cleaning purposes. The stems are hollow and easily separated at the joints. If one would satisfy himself as to the peculiar property which first suggested the use of this rush for scouring purposes, he has only to draw a joint across the edge of his teeth to find it like a file. William Hamilton Gibson shows us, moreover, in "Sharp Eyes," a way to a pretty chemical experiment with it.

If we take a small vial of nitric acid and immerse any ordinary leaf therein, we shall quickly see it dissolve, literally eaten up by the acid. But what does the scouring rush do under such circumstances?

Immediately upon its introduction into the acid the sizzling process begins, the green pulp of the stem is gradually consumed, the tube, however, still retaining its shape, becoming paler and paler in color, until after a few hours, our specimen is transformed into a pure white alabaster-like column which defies any further attack from the acid.

Upon taking it from the vial and washing it carefully in running water, we hold in our hands a beautiful tube of pure, glassy flint, or silex, an object of great microscopic beauty of construction. Our scouring rush is no longer a vegetable, but a mineral, and in observing its skeleton of stone we easily understand the secret of its utility as a scouring brush.

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TABLE OF CONTENTS.

PAGE
I. AGRICULTURE.—Improved Hay Rake and Tedder.—Stoddard's hay rake and tedder as shown at the Chicago Exposition.—1 illustration. 15109
II. ASTRONOMY.—Venus and Her Crescent.—An interesting contribution to popular astronomy. 15110
III. BIOGRAPHY.—Miss Klumpke.—An American lady graduate doctor of science.—Her work in the Paris observatory.—1 illustration. 15109
IV. CHEMISTRY.—Alloys.—By Prof. W. CHANDLER ROBERTS-AUSTEN.—Continuation of these remarkable papers treating of the thermic relations of alloys.—3 illustrations. 15104
Boron Bronze.—By H. N. WARREN.—Composition and characteristics of this alloy. 15105
Distillation Apparatus for the Separation of Alcohol from Mixtures.—An ingenious fractional condensation apparatus for laboratory use.—1 illustration. 15105
Oil of Coprah and Palm Oil.—Chemical analysis of these oils. 15105
Potassium.—Notes on this alkali metal. 15105
V. CIVIL ENGINEERING.—The Jetties at the Mouth of the Mississippi River.—A criticism of the work done for the improvement of the mouth of the Mississippi. 15106
VI. ELECTRICAL ENGINEERING.—Electric cars introduced in Paris, driven by storage battery.—1 illustration. 15109
VII. GEOGRAPHY.—The Hawaiian Islands.—A valuable article on this timely topic. 15103
VIII. GEOLOGY.—Curious Mineral Formations.—Examples from California mines.—2 illustrations. 15108
IX. MEDICINE AND HYGIENE.—Notes on the Treatment and Cure of Cancer.—By NICOLAS PIKE.—A new treatment for cancer by inoculation with erysipelas. 15108
The Dangerous Employment Inquiry.—Unhealthy employments as investigated by an English departmental committee. 15108
X. METEOROLOGY.—Dust and Atmospheric Phenomena.—By Dr. J. G. MCPHERSON.—A valuable and practical paper on Mr. Aitken's recent investigations. 15109
XI. MINING ENGINEERING.—The Formenephone for the Mutual Analysis of Gases.—A curious and ingenious apparatus for the detection of fire damp in mines.—2 illustrations. 15106
XII. MISCELLANEOUS.—An Experiment with the Scouring Rush.—How to obtain the siliceous skeleton of this plant. 15110
A Perpetual Motion of the Eighteenth Century.—A curiosity in the history of science.—1 illustration. 15107
Fumigation with Bisulphide of Carbon.—By H. DU BUYSSON.—The use of bisulphide for destruction of insect life. 15107
Italian Method to Keep Warm.—The curiosity in the household economy of Italy.—1 illustration. 15107
The History of Footgear.—Continuation of this paper.—35 illustrations. 15107
The Talking Watch.—An excellent trick in magic.—2 illustrations. 15108
XIII. NATURAL HISTORY.—What we Know of the Lobster.—By FRED. MATHER.—A graphic and accurate paper on this crustacean. 15103
XIV. NAVAL ENGINEERING.—The United States War ship Columbia.—A full description of the great American war ship, with illustrations.—3 illustrations. 15105
XV. PHOTOGRAPHY.—Photographic Apparatus for Facilitating Focusing.—A simple and effectual reversing apparatus for focusing.—1 illustration. 15108
XVI. PHYSICS.—Formation of Snow in Bright Sunshine.—Exceedingly pretty experiment in thermo-dynamics.—1 illustration. 15108
Studies of the Phenomena of Simultaneous Contrast Color, and on a Photometer for Measuring the Intensities of Lights of Different Colors.—By ALFRED M. MAYER.—The practical application in photometry of the principles explained in these papers.—6 illustrations. 15104
XVII. TECHNOLOGY.—Marshall's Paper Pulp Finisher.—A new type of machine for working paper pulp.—3 illustrations. 15106
Vegetable Parchment.—Its Properties, Uses, and Manufacture.—A valuable and practical paper on this interesting subject. 15107

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